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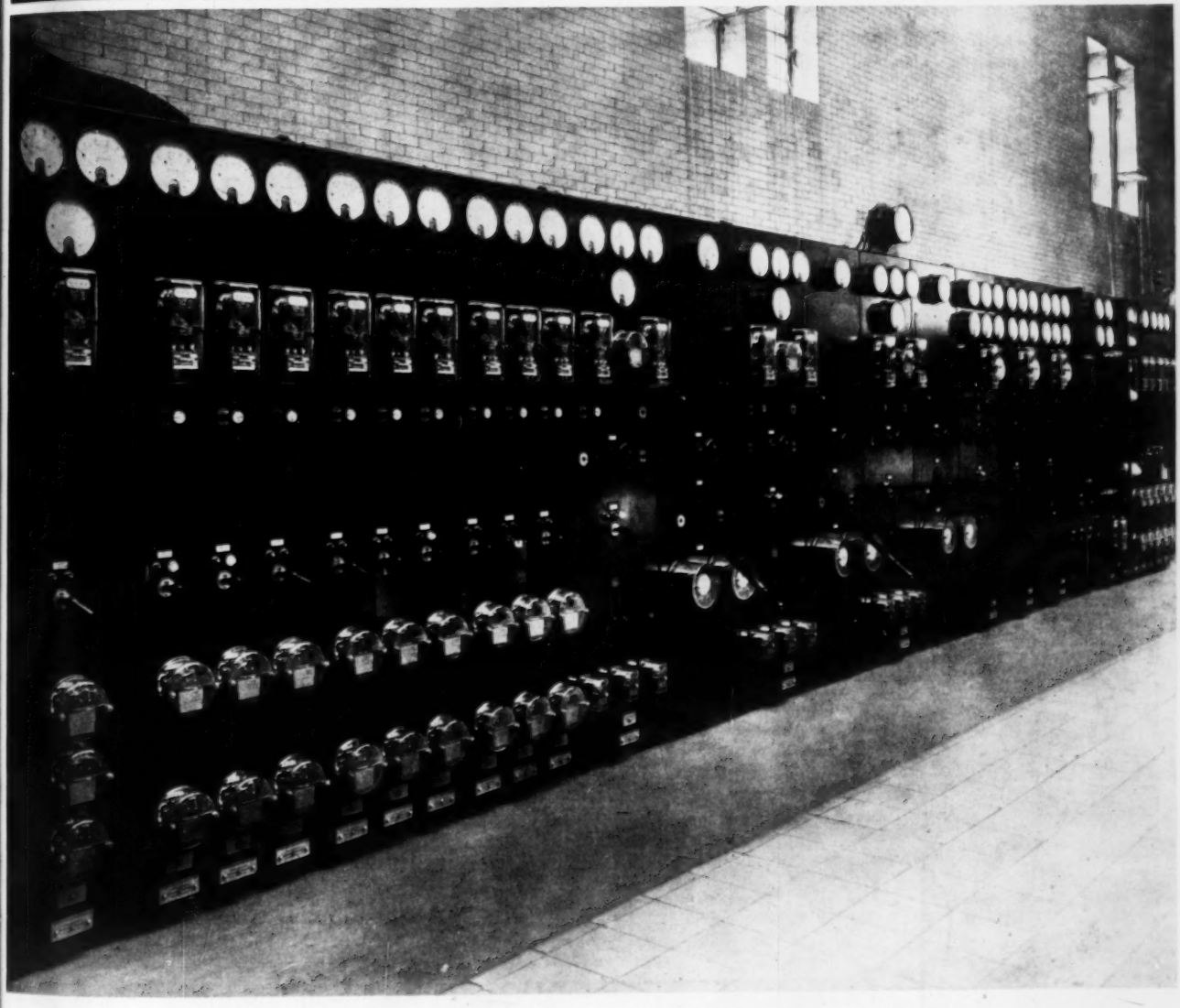
INSTRUMENTS

THE MAGAZINE OF MEASUREMENT AND CONTROL

VOLUME 6 MAY, 1933 NUMBER 5



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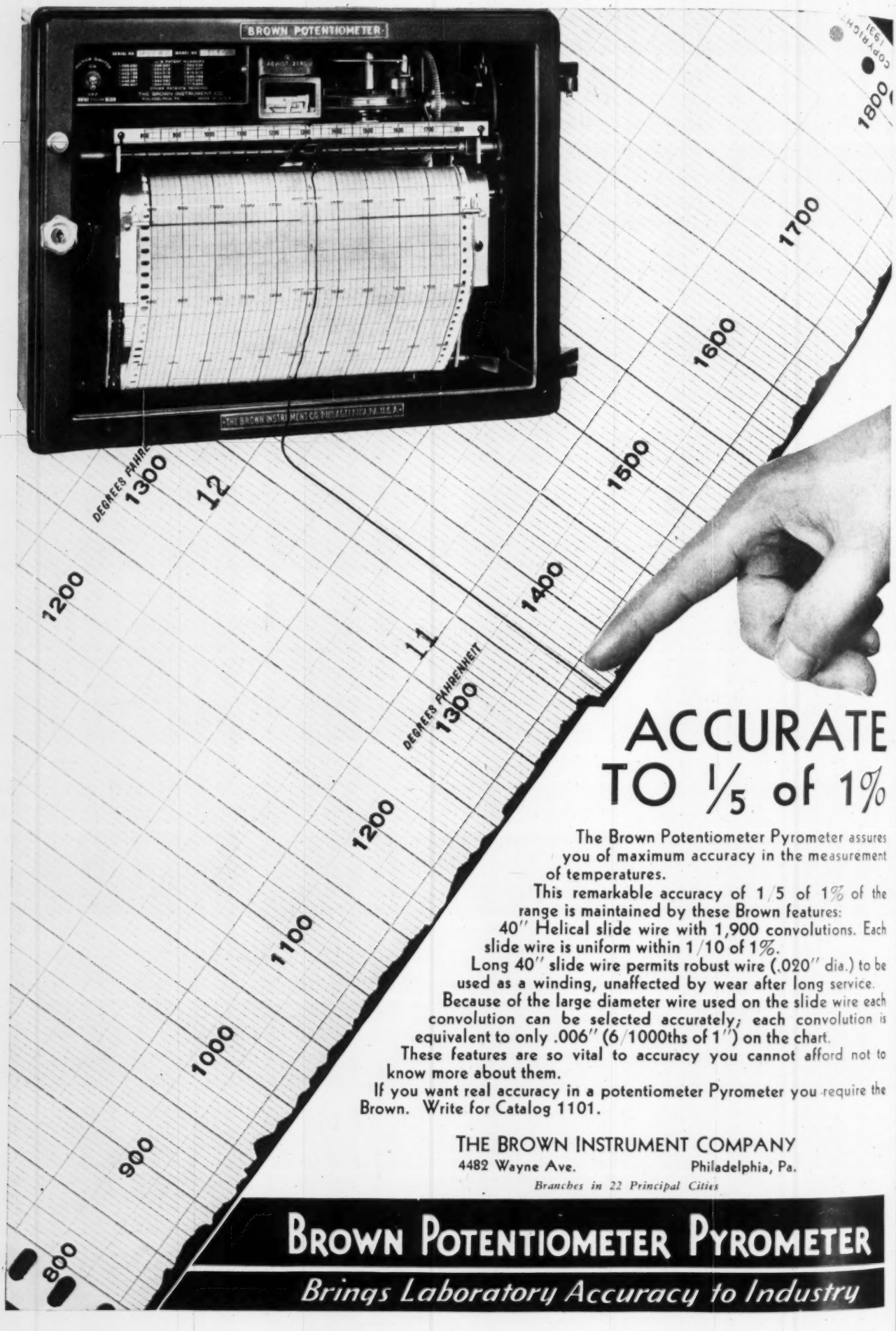

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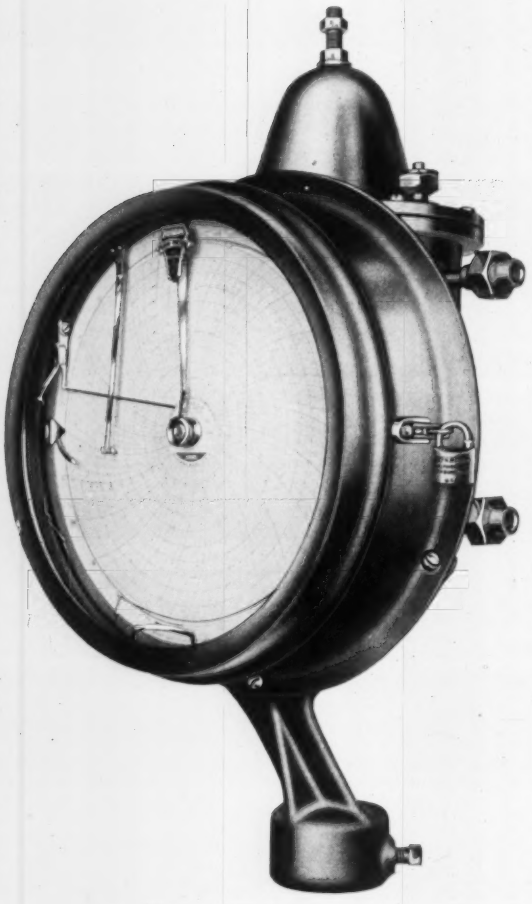

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EDITORIAL COMMENT

In This Issue

♦ As **James Spencer** states at the end of his article on **A Current Stabilizer for Instrument Calibration**, there are other cases where steady voltage or current is essential; hence the wide applicability of the device he describes.

♦ Reversing types of control stations, taken up this month by **F. L. Spangler** in his series on **Control of Fractional Horsepower Motors**, are of distinct industrial interest.

♦ Comparatively simple but extremely useful when properly used are **Maximum Pressure Indicators**, discussed by **Prof. DeJuhasz** in the current instalment of his treatise on Engine Indicators.

♦ "How to Keep Industrial Gas Meters Accurate" might well be the title of this month's instalment of **Béhar's Flow Measurement and Control**. Save his check-list of testing methods for reference.

♦ Forty articles in this month's **New Instruments** section—there's a record for this year! We call them "articles"—not "items"—because all were edited, and most were written, especially for **Instruments** readers.

◆ ◆ ◆

The Front Cover

♦ "Military precision" is the watchword at West Point—not only in the classroom and on the parade ground, but in the splendidly modernized power plant. From the main switchboard shown on our front cover is controlled the entire a.c. system, including also the d. c. end of motor generator sets, also the switchgear in the basement, the turbo generators, etc.

Instrumentation's Year

IT never is the policy of this magazine to foster vain hopes in the minds of its readers. Rash predictions are often made to the editors in letters or by word of mouth, but we take them with a grain of salt, for in the long run the ultra-optimistic prophecies tend to be balanced by the ultra-pessimistic warnings. Nevertheless, after assimilating and digesting a mass of data of all shades, we now can report without bias that Instrumentation faces a brighter immediate future than does industry as a whole.

To be specific, we make two assertions:

1. For the year 1933, the rate of return to normality of the volume of sales of testing, measuring, and controlling instruments and of meters will be higher than that of industry-to-industry business in general.

2. Individual practitioners of Instrumentation will find the demand for their services greater in proportion than will most classes of engineers, operating executives and other technical men who do not specialize in Measurement and Control.

How did we arrive at these conclusions? Suffice it to mention that the most impressive fact in our opinion (we call it a fact though recognizing that extreme conservatism would label it a tendency) is the unprecedented inclusion of Instrumentation in planning, designing and laying out production facilities.

Never before have consulting engineering firms, industrial executives, production engineers, inspection chiefs and laboratory heads exhibited such a thirst for information on the newest—the most improved—measuring instruments, meters and automatic control devices. The statement by Arthur D. Little, Inc., reprinted in this column in our February issue is but one of many significant evidences of this state of mind. Every day's mail received by *Instruments* furnishes added proofs. Subscribers send in many specific requests evidencing that they are in the market for such or such a device, and an increasing number of inquiries is received from non-subscribers urgently requesting that we put them in touch with the best source of supply for certain instrumentation equipment. And it's always "the best source" that they ask for. Seldom do they mention "reasonable prices." Call this a tendency or call it a fact—it seems to be pretty conclusive.

There are of course numerous reasons for this growing importance of Instrumentation. Most of these reasons are related to a keen realization that only those industries can survive and prosper which immediately initiate a thorough modernization of their facilities. Obviously, when there is not enough capital for building a new plant or for replacing boilers, turbines, chemical process apparatus and other *major* items of equipment, modernization must consist of improving products, attaining and maintaining uniformity, cutting unit costs, minimizing reliance on human watchfulness and preventing accidents and shutdowns . . . all of which are definite objectives of Instrumentation, all of which may be attained by installing relatively "minor" measuring and controlling equipment.

Between the lines of the Progress Reports submitted in January 1932 and January 1933 by the American Engineering Council's Committee on the Relation of Consumption, Production, and Distribution, engineers concerned with measurement and control may discern some of the powerful factors giving rise to the trend we have noted.

To which we may add in conclusion an isolated example—which lacks, of course, the weight of such scholarly research as the Committee's but is nevertheless indicative of changing conditions: A plant instrument man who recently placed a large order for controlling pyrometers was asked how it came about that his firm appropriated for that purpose an amount running well into five figures. Prompt and sure came his reply: "Three years of low tonnage decreased enormously the number of employed expert furnace men able to work by eye, and those that were kept on the job are somewhat out of practice. But" (and here he grew emphatic) "even if we could hire tomorrow a full quota of trained-to-the-minute experts, their human skill would no longer meet the requirements imposed by the standards to which our products must come up."—M. F. Behar.

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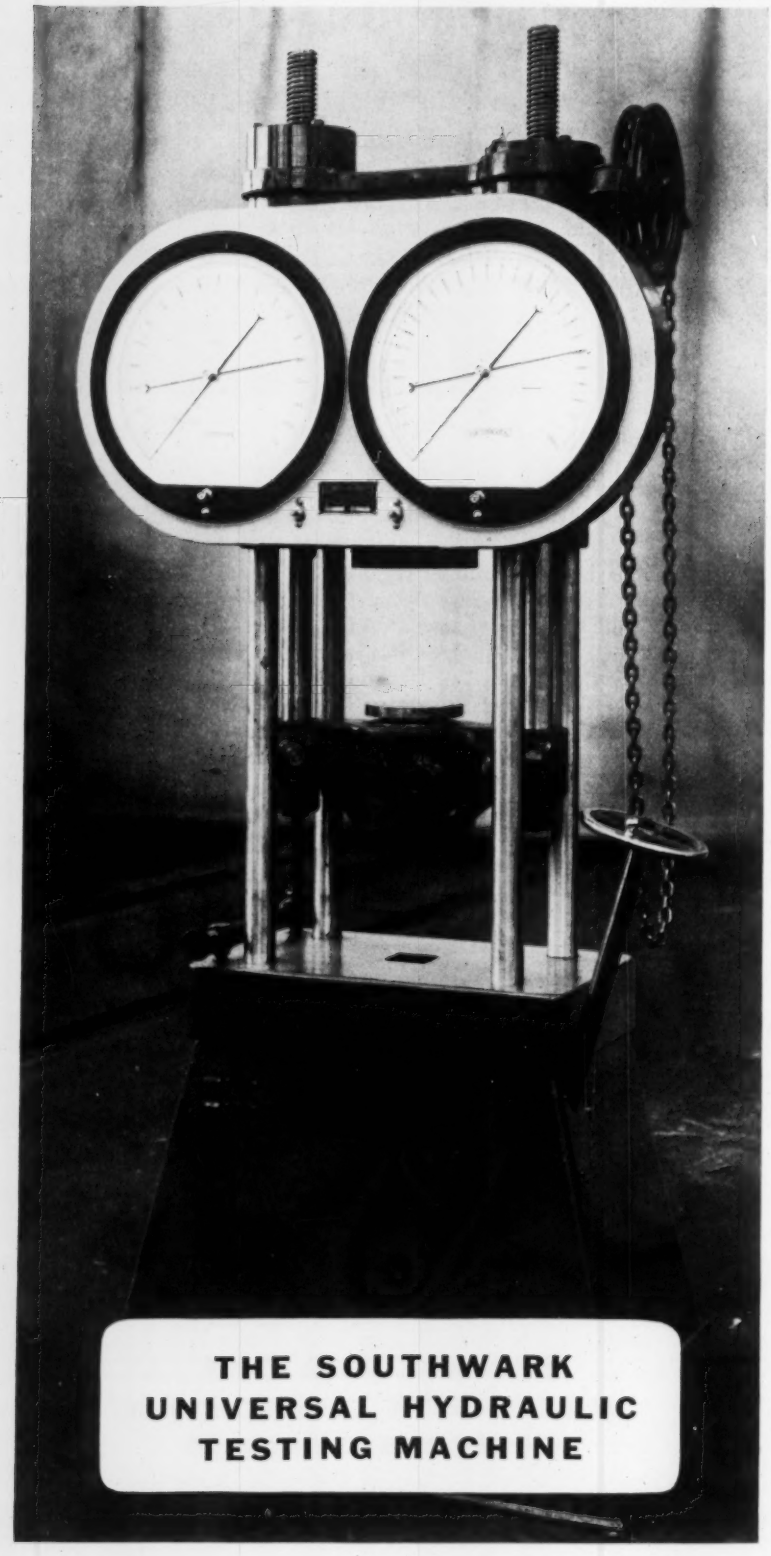

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A CURRENT STABILIZER for INSTRUMENT CALIBRATION

By JAMES SPENCER*

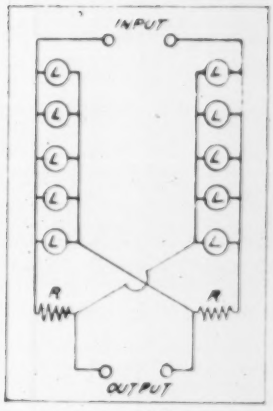


Fig. 1. Connection diagram of Current Stabilizer
R 175 ohm resist
L 10 25-W lamps

A STEADY electrical supply plays a very important part in the testing and checking of electrical instruments. For this reason current stabilizers have been installed in the test department to produce the effect. The current stabilizer is a device that allows for a considerable change in line voltage without effecting a change in the predetermined value of output current. Its construction is simple, the equipment being mounted on a flat base board. Twelve lamp sockets are required and sufficient wire to connect the device as shown in Fig. 1. Five 25-watt tungsten lamps, and two 175 ohm non-inductive resistors constitute the bridge arrangement. A 100:5 current transformer with a variable resistor connected as shown in Fig. 3 completes the equipment necessary to build the device.

The current stabilizer operates on the well known bridge principle, making use of the non-inductive resistors in two of the arms and a bank of lamps in each of the opposite two arms of the bridge. As the wheatstone bridge depends on the fact that there is no current flow between two points of equal potential, so the current stabilizer makes use of the fact that a steady current will flow if the difference of potential between these two points does not vary. Also, as the galvanometer of the wheatstone bridge does not move under balanced condition, so the output of the current transformer connected across the diagonal of the bridge of the stabilizer does not change.

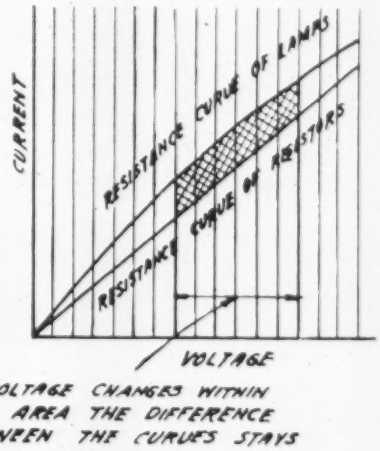

CURRENT
RESISTANCE CURVE OF LAMPS
RESISTANCE CURVE OF RESISTORS
VOLTAGE
IF VOLTAGE CHANGES WITHIN THIS AREA THE DIFFERENCE BETWEEN THE CURVES STAYS APPROX THE SAME

Fig. 2

Curves taken on the device are characteristic of those shown in Fig. 2. From these curves it will be noted that the resistance of the resistor arms remained constant under all values of voltage; while the resistance of the lamps varied, however, the potential across the diagonal of the bridge remained constant between 70 and 130 volts. It is between these values of voltages that the stabilizer operates efficiently. As the ratio of all four arms remain constant between these values of voltage, it can readily be seen that the potential across the diagonal of the bridge will not vary unless the load is changed, therefore, with no change in voltage across the transformer the current in the secondary is constant. The current setting will remain constant unless the voltage across the bridge rises or falls outside the limits as stated above. In test for calibration purposes the current is changed to different values by manipulating a variable resistor connected across the primary of the transformer.

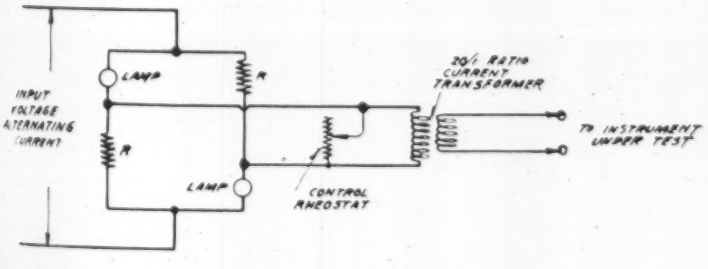


Fig. 3. Diagram of connection for ammeter test.

In the test room this device is used as a supply to calibrate and check various types of ammeters. The outfit as explained in this article is sufficiently capable of operating several standard type switchboard instruments at one time. However, by varying the combinations of resistors and lamps the stabilizer can be made other capacities.

Current stabilizers were installed in the test room primarily for the purpose of insuring instruments of greater accuracy, and second, protect operators from eye strain or fatigue due to reading instruments where unsteady current causes the pointer to oscillate. In instrument work two operators are required to calibrate, one to read the standard and the other to check the instrument under test. As the operator reading the standard sights the calibration point he indicates it by either sign or sound and the other operator checks the reading of the instrument under test. During the time of sighting the calibration point on the standard and checking the point on the test instrument the current might vary and a wrong check would be given the test meter.

While we have tried to explain in this article the use of the current stabilizer in instrument test work, the reader will probably think of many other applications where a device of this kind might be used to afford a steady voltage or current.

*Westinghouse Elec. & Mfg. Co., Newark Works.

With deep sorrow *Instruments* records the death of its old friend and subscriber **Colonel Alfred Fellows Masury** in the "Akron" disaster April 4.

Control of Fractional-Horsepower Motors

By F. L. SPANGLER*

(Continued from March issue)

Reversing of Motors

D.c. motors having series, shunt, or compound-wound fields are reversed by reversing the current in the armature or in the field.

Single-phase a.c. motors that start with a split-phase winding are sometimes equipped with terminal plates to which the leads are brought out and arranged so that the direction of rotation can easily be changed by reversing the leads, which reversal may be accomplished by hand or with external switch. This type of motor, however, is not suitable for frequent reversing service since the rotor must come virtually to standstill before the terminals are changed, as otherwise the motor will not reverse.

Standard single-phase motors that start with a shaded-pole winding cannot be reversed in direction.

Single-phase motors of the repulsion-start type cannot be reversed unless equipped with both forward and reverse windings, in which case a single-pole switch can be used to connect to either one winding or the other.

2- and 3-phase a.c. motors are reversed by reversing both leads of any one of the phases.

Manually operated reversing switches may be operated by push buttons or equipped with levers for operation by the hand, foot, rope, shipper rod, or other means.

For d.c. motors greater than ¼ h.p. and a.c. motors exceeding ½ h.p. in capacity, the drum-type switch is often used because of its ample capacity. This type of switch can be provided with a sufficient number of fingers to break all circuits to the motor and motor field when the lever is in the "Off" position.

Figs. 12 and 13 illustrate reversing switches having the same mechanism but designed for different types of service, and Fig. 14 shows the wiring diagram for this type of switch used with a series-wound motor. The switch shown in Fig. 12 is enclosed in a sheet steel box and is designed for ordinary service. Where the switch must be made water-tight or explosion-proof, the mechanism is operated by a shaft extending through the cover of the enclosing box. On this can be mounted various types of levers for operation by thumb, hand, foot, rope, or shipper rod. Movement of the lever to the "Forward" position rotates the shaft in one direction and movement to the "Reverse" position rotates the shaft in the opposite direction, closing a different set of contacts.

The box and cover of the water-tight switch shown in Fig. 14 are castings with a rubber gasket. Where explosive vapors, gases, or dust exist, the gasket is omitted and the faces of the cover and box are machined to a tight fit, resulting in a switch that will withstand the force of an internal explosion and will confine the hot gases from the explosion so that they cannot ignite any gas in the room. This type of switch can also be furnished with a forked lever for use as a limit switch, in which case, should the moving object overtravel its limit, it trips the switch and causes the motor to reverse.

Where the motor is to be operated in either direction for short intervals, the switch used is generally of the momentary-contact type, in which case the motor operates in either "Forward" or "Reverse" only as long as the "Forward" or "Reverse" button is held in or the lever is held in the "Forward" or "Reverse" position. When the button or lever is released, it returns to its normal or open position and stops the motor. This type of control is used for operating doors and valves and in numerous other applications.

Used with d.c. and single-phase a.c. motors, these switches open both leads to the motor but do not disconnect the field from the supply line. They disconnect only 2 of the leads to polyphase motors.

Where the motor operates in either direction for a period of, say, a minute or more, the switch is designed with maintained contacts so that when the button is pushed in or the lever is moved to either the "Forward" or "Reverse" position, the switch remains closed and the motor continues to operate until the direction is reversed by pushing in the other button or moving the lever to the other position. Switches provided with levers for their operation and with maintained contacts can also be supplied with a centering spring, thereby giving three positions: "Forward," "Off," and "Reverse." Both buttons or the 2 positions of the operating lever furnished with reversing switches may be designated "Forward"-"Reverse," "Up"-"Down," "In"-"Out," etc.

Applying the Drum Type of Switch

A drum switch for the manual reversing of motors is shown in Fig. 15 with the cover removed, exposing the contacts and terminal lugs. With the enclosing case omitted, this drum can be mounted into the housing for a motorized machine by means of mounting bolts passing through the top plate of the drum. These drums may be of either the momentary or maintained contact type, just as in the push-button type of switch previously described. The hand lever is easily replaced with other types of levers for operation by rope or shipper rod.

Fig. 16 shows 2 connection diagrams for a 6-finger drum. For d.c. and single-phase and 3-phase a.c. motors, this drum

(Continued on Page 101)

*Industrial Engineer, Allen-Bradley Co.

Fig. 12. This push-button station can be used for the starting, stopping, and reversing of fractional horsepower motors. The motor current may be handled directly by the push button mechanism or by a magnetic switch which, in turn, is controlled through the push-button station.

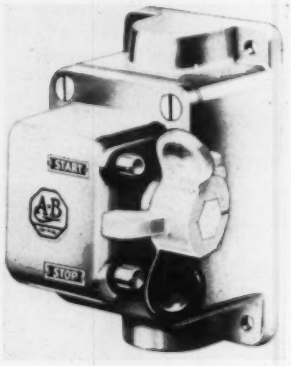


Fig. 13. This control station employs the same mechanism as the push-button station shown in Fig. 12 but is of water-tight construction.

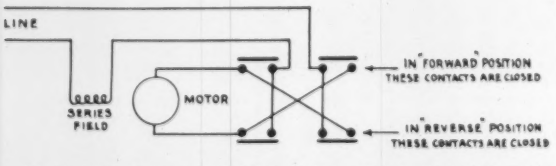


Fig. 14. Connections of reversing switch of types shown in Figures 12 and 13.

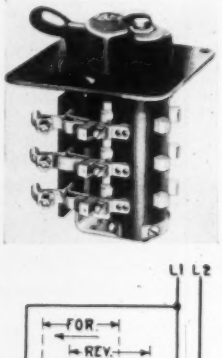
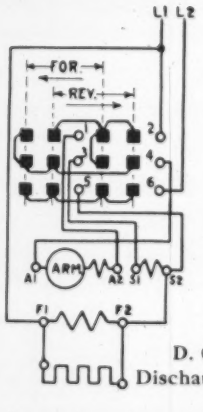
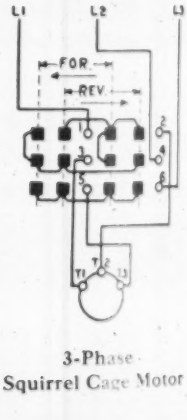


Fig. 15. Drum-type manually operated reversing switch without enclosure.

Fig. 16. Connections of reversing drum shown in Fig. 15 when used with d.c. and three-phase a.c. motors.



D. C. Motor
Discharge Resistor



3-Phase
Squirrel Cage Motor

The ENGINE INDICATOR

Its Design and Theory

By KALMAN J. DeJUHASZ*

(Continued from April issue)

MAXIMUM PRESSURE INDICATORS

While for a thorough analysis of the engine cycle it is necessary to determine all the pressures of the cycle, for many purposes the knowledge of the maximum pressure alone is sufficient. A complete indicator card contains, of course, also the maximum pressure, and in such cases in which the indicator card is easily obtainable by means of a normal indicator, there is no real need for a special device for finding the maximum pressure. However, in cases of engines, which can be indicated only by means of the more complicated and expensive types of high speed indicators, time and inconvenience is saved by the use of much simpler devices. A number of maximum pressure indicators have been developed and used for the determination of compression pressures, as well as maximum explosion and combustion pressures in Otto and Diesel cycle engines and for detonation research.[28] There is a method by means of which the maximum pressure can be determined by the aid of a normal pencil indicator, without the error source of the inertia effect even in the case of fairly high speed. This method is illustrated in Fig. 102 and consists in pushing a wedge-shaped fork between the head of the indicator piston rod and the cylinder cover and displacing thereby the indicator spring, until the pencil movement, caused by the fluid pressure, ceases. The position of the pencil will then indicate the maximum pressure.

The Okill maximum pressure indicator shown in Fig. 103 is based on a similar principle. It consists of a spring loaded piston subjected to the cylinder pressure and a pointer showing the movement of the piston. By means of a knurled nut the spring can be compressed and the spring force increased until it just equalizes the maximum cylinder pressure. When this condition is attained the pointer ceases to move. Graduations on the knurled nut and on the cylinder barrel show the compression of the spring and the corresponding pressure. In the recent construction of the instrument a suitably arranged counter supersedes the graduations formerly used. In a further refinement of this device an electric contact is fitted to the vibrating tell-tale finger which operates a signalling lamp (Fig. 103a).

In the maximum pressure gage developed by Prof. P. Langer[29] (Fig. 104) the gas forces acting upon the indicator piston d are counterbalanced by the attraction of the electromagnet b the force of which can be changed at will by changing the current flowing through the windings of the electromagnet by means of the rheostat f. The instrument indicates whether a predetermined pressure is attained or surpassed. The pressures corresponding to the readings of the ammeter e are determined by calibration and can be marked upon the dial of the ammeter itself. The position of the lever a is recorded on a strip of paper by a pencil which is actuated by another electromagnet which is energized or deenergized according to whether the contact c is made or broken.

*Asst. Prof. of Engineering Research, Pennsylvania State College.

[28] C. W. Hicks. The Measurement of Maximum Cylinder Pressures. *National Advisory Committee for Aeronautics, Technical Report 294*, 1928, 11 pages. Several maximum pressure indicators are described.

[29] P. Langer. Fahreigenschaften von Dieselmotoren und Vergasermotoren in Nutzkraftwagen. *Dieselmaschinen V, des Vereines deutscher Ingenieure*, 1932. The electro-magnetic gage for maximum pressures is described on pages 85-89.

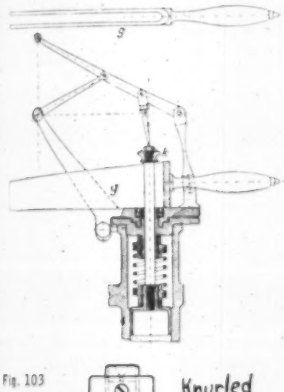


Fig. 102. Wedge-method of measuring maximum pressure.

Fig. 103. Okill Maximum Pressure Indicator (G. Taylor, Ltd., Bolton, England). By turning D with reference to the stationary C the spring is compressed and the spring force, being proportional to the compression of the spring, can be read upon the counter. The counter gives directly the pressure acting upon the piston, in lbs. in.^{2}

Fig. 103a. Okill Maximum Pressure Indicator with electrical signaling arrangement (1) lubricator knob; (2) water cooled body; (3) electric contact. (Battery and lamp are housed in a portable box not shown.)

Fig. 103

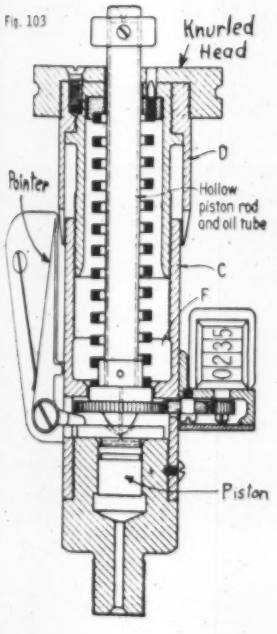
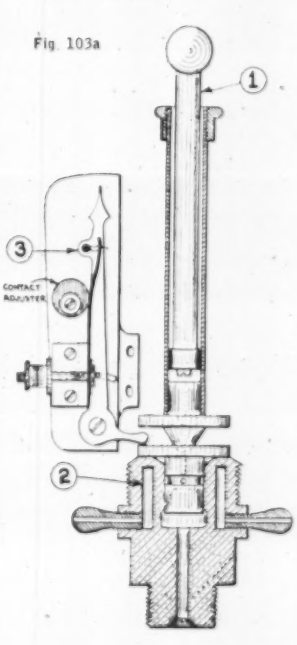


Fig. 103a



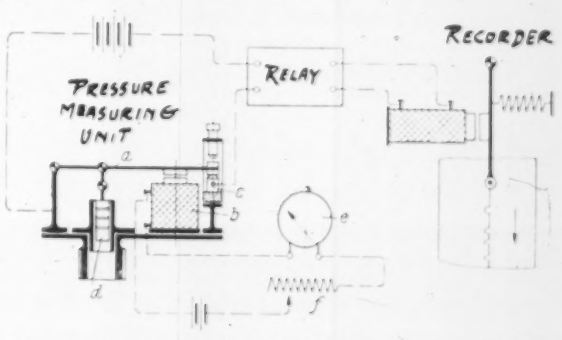


Fig. 104. Maximum pressure indicator for automobile engines (Langer). The apparatus records when a predetermined pressure is attained or exceeded. a lever; b electromagnet; c contact; d indicator piston; e ammeter; f rheostat.

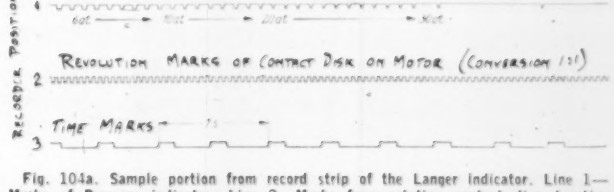


Fig. 104a. Sample portion from record strip of the Langer indicator. Line 1—Marks of Pressure indicator; Line 2—Marks from rotating contact disc denoting engine revolutions; Line 3—Time marks.

On the same strip of paper are drawn two other lines; one of them recording the number of revolutions of the engine with the aid of a contact disk attached to the engine shaft; the other line records the time with the aid of electric contacts received from a clock. A sample diagram is shown in Fig. 104a. In this case the current of the electromagnet *b* was gradually increased until the pencil showed only occasional interruptions. The record shows that the pressure of 30 atmospheres (425 lbs./in.^{2}) was reached only occasionally.

The Bosch Maximum Pressure Indicator (Fig. 105) built by the United American Bosch Corporation is based on a principle somewhat similar to the Okill but it is adapted to the high pressures occurring in fuel injection systems, up to 1000 atmospheres (14000 lbs./in.^{2}). By adjusting the compression of the calibrated spring *2* the nozzle *1* can be set to open at any predetermined pressure which can be read off from the scale of the graduated nut *3*. The instrument is inserted, in series, into the fuel line. Should the fuel pressure in the latter exceed the pressure to which the valve *1* is set then this latter will eject fuel. By adjusting the regulating nut *3* a just perceptible spray can be obtained from the nozzle. The pressure then shown on the graduated barrel will correspond to the maximum pressure in the piping. This instrument is a useful aid in the tuning up of a multicylinder engine to equal opening pressure of all nozzles, in measuring the resistance of the fuel piping and also as a safety valve when making experiments in engine development work.

In high speed engines generally, and in the case of detonation especially, the peak pressures are reached by a very rapid pressure rise, and their duration is extremely short. For such service the maximum pressure indicator must have extremely light moving parts. This requirement has been kept in mind in the so-called "Acrometer" of Mazellier and Carpentier which consists of a very light disk type of non-return valve inserted between the engine space and an accurate pressure gage (Fig. 106). The gases are entrapped above the valve in the pressure gage until the pressure in it equals the maximum pressure in the engine. There is the error, however, that the areas exposed to the pressures on both sides of the valve are not equal, owing to the area of the seat. Furthermore, the light valves deteriorate rapidly under the heat, pressure and vibration conditions to which they are subjected.

Both the balanced diaphragm (Bureau of Standards) and the balanced valve (Farnborough) type of indicator, as described previously, can be used as a maximum pressure indicator. In contradistinction to the previously described instruments these latter two apparatus use an outside air (or gas) supply and not entrapped cylinder gases. In such application there is no need for the timing device and therefore the operation is greatly simplified. Only the telephone (or spark point, or neon lamp) is needed in order to indicate the cessation of the electric contact, i.e. the attainment of the maximum pressure.

The balanced diaphragm type maximum pressure indicator developed by the National Advisory Committee for Aeronautics[30] is illustrated in Fig. 107. The apparatus consists of a pressure element, a source of controlled high pressure and an electric circuit including a neon lamp. The pressure element screws into a metric spark plug hole; therefore the diameter of the diaphragm is limited to $\frac{1}{2}$ in. and is clamped down to $\frac{3}{8}$ in. free diameter. It is made of Swedish blue tempered spring

[30] J. A. Spanogle & J. H. Collins, Jr. Maximum-Pressure Indicator. *National Advisory Committee for Aeronautics, Technical Note* 359, 1931, 7 pages.

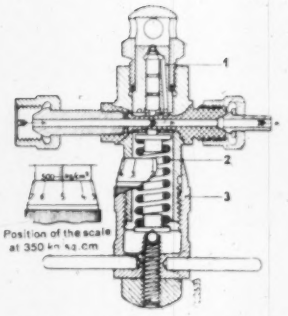


Fig. 105. Peak Pressure Indicator of Robert Bosch. A nozzle valve with a carefully calibrated spring is interposed into the fuel line of an injection system and the spring pressure adjusted until the valve leaks. The corresponding pressure can be read by the compression of the calibrated spring.

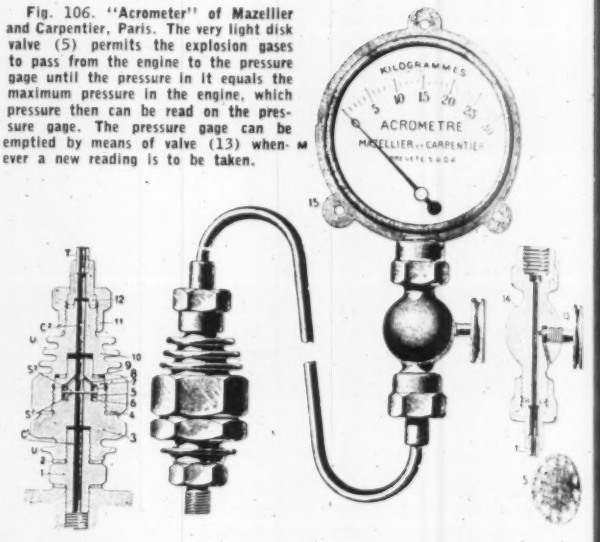


Fig. 106. "Acrometer" of Mazellier and Carpentier, Paris. The very light disk valve (5) permits the explosion gases to pass from the engine to the pressure gage until the pressure in it equals the maximum pressure in the engine, which pressure then can be read on the pressure gage. The pressure gage can be emptied by means of valve (13) whenever a new reading is to be taken.

steel, as thin as the pressures to be measured will permit, 0.004 in. thick for pressures up to 800 lbs./in.^{2} and 0.008 in. thick for pressures up to 1500 lbs./in.^{2}. The diaphragm is mounted between perforated supports which allow it approximately 0.005 in. movement at its center and restrain it so that it is never distorted beyond the elastic limit. (It has been calculated that a pressure of 4 lbs./in.^{2} is sufficient to deflect a 0.004-in. diaphragm to make contact.)

The balancing pressure is provided from an air bottle connected to the pressure element through a control block on which a Bourdon spring gage is mounted. Whenever the engine pressure exceeds the controlled air pressure the diaphragm makes a contact and the neon lamp

(Continued on Page 101)

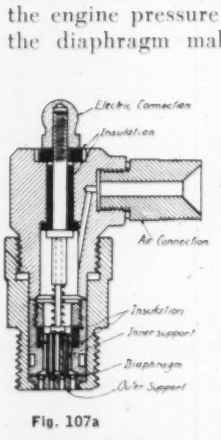


Fig. 107a

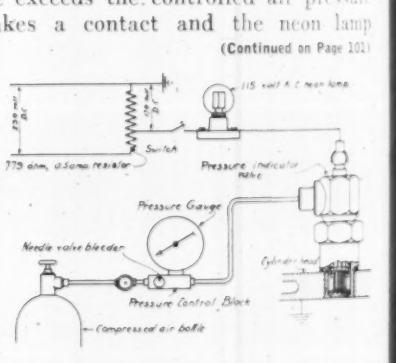


Fig. 107b

Fig. 107. N.A.C.A. Maximum Pressure Indicator of the Balanced Diaphragm Type. A sufficiently flexible diaphragm is mounted between 2 perforated supports. On the lower side the diaphragm is exposed to the engine pressure, while on its upper side it is exposed to a controlled pressure. Whenever the diaphragm bends over from one support to the other it makes or breaks the electrical circuit of a neon lamp. As long as the balancing air pressure is below the maximum pressure of the engine cycle, the neon lamp flickers; the flickering ceases when the balancing pressure exceeds the maximum pressure of the cycle. This pressure can be read upon a pressure gage interposed into the balancing pressure pipe. Fig. 107a shows the pressure unit and Fig. 107b a diagram of the installation complete with the neon lamp circuit.

Flow Measurement and Control*

By M. F. BEHAR†

CHAPTER XXIII
POSITIVE METERS
(Continued)

8. Positive Gas Meters—General Considerations
(Continued from April)

(b) Standards and Their Uses

Most of the positive gas meters designed for industrial service possess a high order of *intrinsic* accuracy. When an industrial meter is properly used, the difference between its registrations and the true volume should seldom exceed half of one percent. Unfortunately, the impression prevails among engineers that such accuracy is not attainable in practice. We shall undertake to show that it is attainable.

Obviously, in order to determine small errors, the instruments employed for the calibration or "proving" of meters must not only possess an even higher order of intrinsic accuracy but their accuracy *in use* by men without scientific laboratory training must be such that their registrations can unquestionably be accepted as departing from the true volumes by not more than 0.3%. It also goes without saying that the practical standards employed for calibrating meter provers or test meters must be not only even more accurate but—most important—so simple and durable that after being certified initially by the Bureau of Standards, they should not have to be shipped again to the Bureau unless accidentally damaged.

The primary standard of volumetric gas measurement, by definition, is the cubic foot. The practical cubic foot standards (Primary Standards at the Bureau and Secondary Standards commercially available) are (1) cubic foot bottles and (2) portable cubic foot standards. These are not meters but containers or measures, corresponding to "sealers' cans" or standards of liquid measure. Cubic foot bottles consist of hollow cylinders with ends tapering down to two narrow necks, and of tanks and other appurtenances. Portable cubic foot standards are inverted-bell devices similar in design to gasometers or meter provers. The principal use of bottles and of portable standards is to calibrate or "bottle" the *scaled* standards which in turn are used to calibrate or "prove" meters. In other words, cubic foot standards are reference standards, like Johansson blocks or other linear standards that are used to calibrate measuring machines; or like standard cells, standard resistances, and other *fixed-value* standards. See Art. **(c)**.

Gasometers or test-holders or bell-type *meter provers* (as they are best known) correspond to the calibrated tanks that are used for proving liquid meters. Their principal use is to check the accuracy of registration of ordinary low-pressure positive gas meters. See Art. **(d)**.

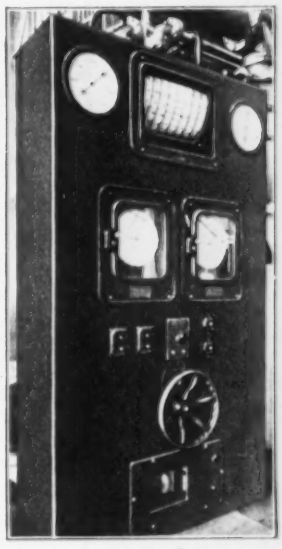
In general, then, *meters are "proved"* by means of bell type provers and *provers are "bottled"* by means of bottle or bell cubic foot standards.

This summarizes the routine of gas companies and gas meter manufacturers, based on the ascending order of accuracy of ordinary meters, of provers and of cubic foot standards. It also applies *in general* to industrial positive gas meters but we must note here the first significant exception: that of the wet drum meters (see §10) which include large station meters and small precision meters. These latter types are used in almost every industrial plant laboratory and on some production applications. Their attainable accuracy is of the same order as that of commercial types of bell provers. Their calibration, therefore, usually consists of "bottling" instead of "proving." For this purpose there are *one-tenth* cubic foot bottles.

Thus far, we have only mentioned positive measurement devices and methods. Such are the connotations of the word "inferential" that none but

*Part Six of *The Manual of Instrumentation*.
†Engineering Editor.

FOR BOILER CONTROL



THE BAILEY BOILER PANEL gives complete information for controlling boiler operation. It contains the Bailey Boiler Meter, a Bailey Fluid Meter with which is combined a Boiler Water Level Recorder, and a Bailey Multi-Pointer Gage. The operator has everything right before him to obtain the desired capacity and best efficiency at all times. Request recommendations for your boilers.

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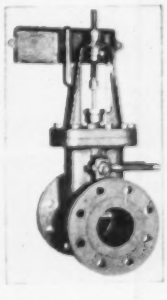
Extremely accurate gages embodying the dead weight gage tester principle are available in several sizes up to 36" in diameter for indicating at remote points the pressure of steam, water, gas, etc. These gages can be used with any pressures and are particularly suitable for magnified ranges. Ask for Bulletin No. 70.

LONG DISTANCE INDICATOR

Bailey Meter Selsyn Operated Equipment for recording and indicating pressure, temperature, draft, liquid level, etc. at any distance from the source is highly accurate and reliable. Described in Bulletin No. 110.



ADJUSTABLE ORIFICE

The Bailey Adjustable Orifice is for use with Fluid Meter installations where accurate measurements are desired over a flow range of as wide as 160 to 1. Ask for details.

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INSTRUMENTS BOOK SHELF

The Selenium Cell, Its Properties and Applications. G. P. BERNARD. Richard R. Smith, Inc., New York, 1930. Cloth, 6x10 inches, 331 pages. Price $9.00.

The best insight into this book is given by the French quotation which the author sets at the front of it. "... there is no better way of knowing how to advance science than by knowing the road over which it has advanced to date."

More specifically, the book aims to give a survey of the existing knowledge, and a guide to the accumulated literature, on the selenium cell and its applications. It presents both most thoroughly and completely.

Of course a book of this nature is of value only to a special class of readers —in this case the workers in the photoelectric field. But to these its value is indeed considerable. One factor which makes the book decidedly valuable to all workers in the photoelectric field, and particularly those working on control applications, is not even to be suspected from the title. That is the fact that the book goes very extensively into the applications of the selenium cell (over one-third of the whole book being devoted to them). And methods of application for the selenium cell are very much the same as for all other photocells. Consequently it is a most helpful source of material on the whole field of photo-cell applications. For instance this book mentions an early device which, using selenium cells in a balanced circuit arrangement, gives a follow-up device for searchlight beams (Meisner arrangement, Fig. 160). The G.E. photo-cell recorder, a much later device using much later types of photocells, nevertheless uses very much the same balanced circuit follow-up device to follow the beam from a galvanometer mirror.

TABLE XXII-2—CHECK LIST OF STANDARD GAS MEASURES AND POSITIVE GAS METER TESTING AND CALIBRATING

Measures and Meters	In Standard Laboratory	In Meter Shop or Plant Laboratory	On Location or in the Field
1. Cubic foot bottles	A, 1		
2. 1/10 cubic foot bottles	A, 2		
3. Portable cu. ft. standards	A, 1		
4. Bell types of provers		1, 3	
5. Low-pressure types of flow provers		4, 14[a]	
6. Pierce critical flow provers		4, 14[a]	
7. Installed orifices			5, 6
8. Wet-drum test meters		1, 2	
9. Diaphragm test meters		1, 4	
10. Rotary meters		4[b]	5, 6
11. Small-low-pressure diaphragm meters		4, 8, 9	5, 9
12. Large low-pressure diaphragm meters		4, 9	5, 7, 9
13. Small high-pressure diaphragm meters		5, 6[c], 13[a]	5, 6, 7, 9
14. Large high-pressure diaphragm meters		5, 6[c], 13[a], 14[a]	5, 6, 7, 9
15. Small wet-drum meters		1, 2, 8	3, 8
16. Station meters		4[b], 5	5, 7
17. Nutating bell meters		4, 8, 9	5, 6, 7

A. Precision weighing of distilled water displaced between gage marks, use of scientific laboratory facilities, micrometric measurements, etc.

[a]High grade and well calibrated for such use

[b]Special large-capacity provers in meter manufacturer's laboratory

[c]When pressure on meter $>$ 15 lb

strictly positive containers or measures can be primary standards. Not even a "total flow" device can be accepted as a primary standard. Nevertheless, there is no reason why an inferential or rate-of-flow meter known to be accurate to, say, 0.1% cannot be used to test, prove or calibrate a positive meter of service grade. In recent years so much work has been done on the orifice principle and other head metering methods (see Chap. XXV) that various devices known as *flow provers* are winning increasing acceptance as portable secondary or field standards for proving meters. Born of necessity, they have evolved into lusty challengers of the bell provers' supremacy but they are chiefly used to check large meters on field locations remote from meter shops.

Flow provers may be divided as follows: (1) Low pressure flow provers: *a)* "funnel" and other multiple-hole types, *b)* single orifice type; (2) Critical flow or "Pierce" orifice prover. These are described below in Arts. (e) and (f).

Similar in principle to the flow provers is the *inserted orifice*, permanently installed in series with a field meter where location permits such an installation. See Art. (g).

A positive gas meter may also be "proved" by means of another positive gas meter in series with it, provided of course that the latter is not only more accurate but otherwise suitable for the purpose. In some cases, high-grade wet meters serve as standards; in others, high-grade diaphragm meters, known as test meters. Most of these are distinguishable at a glance by large "observation" dial registers, and at least one of them—the Emco Test Meter (Pittsburgh Equitable Meter Co.) is of special construction throughout, with aluminum case, etc.

From the foregoing it may be seen that there is a choice of methods and devices for calibrating almost every type of measure or meter. Table XXII-2 is a brief check-list of what to use (1) in a scientific laboratory such as that of the Bureau of Standards, (2) in a meter shop or plant instrument department, and (3) in the field or on location.

(c) Cubic Foot Standards

Immersion Type Bottles

This is the type most widely used in the United States, not so much because it is as convenient as other types but because the immersion type bottles made by various American firms are instruments of precision. A feature of this

type is that the lower end of the bottle is open and unmarked—the bottom of the lower neck constituting the "mark." The upper neck is a glass tube and bears a gage mark defining the cubic foot. The bottle is so supported that it is readily lowered into or raised from the tank below it. When lowered, liquid enters through the lower neck, displacing exactly one cubic foot of air or gas. When raised, one cubic foot of air or gas is drawn from the prover (or test meter) being bottled or calibrated. The bottle may be used, therefore, to transfer air or gas to or from the apparatus under test ("bottling into prover" or "bottling out of prover"). The bore area of the upper neck gage glass is gen-

Fig. 22-55

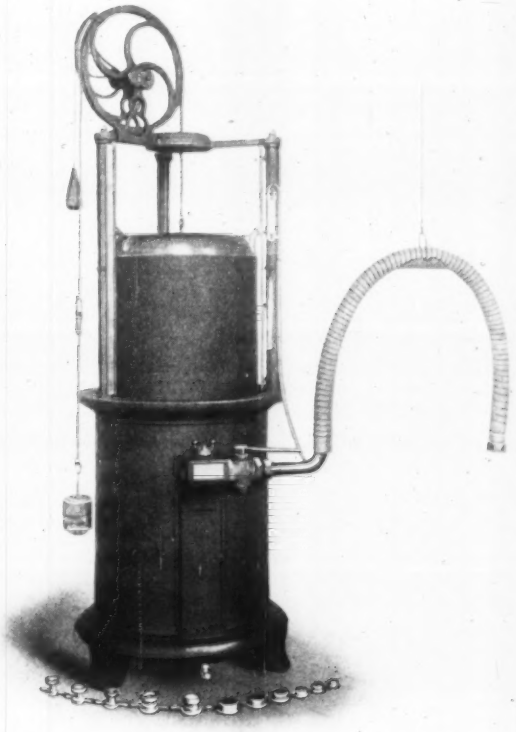

Fig. 22-57

erally <0.7 sq. in. and the liquid level can be read to <0.05 in., so that the "degree of precision" or *intrinsic* limit of error of the bottle itself is <<0.00005 cu. ft. (<0.005%), but it would take extraordinary skill to transfer this degree of accuracy to the meter prover or test meter being bottled, and a miracle to transfer it thence to a service meter. We mention the fact, nevertheless, to hint that the present errors tolerated in metering gases or air in industrial plants can be reduced.

Errors in bottling bell provers or test meters arise from variations in temperature, pressure and humidity. The following precautions should therefore be observed:

(1) The work should be done in a room the air of which is maintained at constant temperature and 100% relative humidity.*

(2) The testing medium should be saturated air rather than dry gas, for dry air or gas would absorb vapor from the sealing liquid while it is being measured off by raising or lowering the bottle.

(3) The liquid should preferably be an oil of low vapor pressure ("G. E." transformer oil, mineral seal oil, etc.) to make sure that evaporation will not cool the contained air or gas. Its viscosity should be low—otherwise it would cling to the inner surface of the bottle, reducing its gas capacity between gage marks.

These precautions apply especially to the bottling of bell type provers.

Fig. 22-55 shows the American Meter Co.'s immersion type bottle.

Cabinet Type

This type is characterized by two tanks, one above and one below the bottle, which is fixed in place and which has gage glasses at both its upper and lower necks. A system of tubes, 3-way cocks, etc., makes it possible to raise the

*It is surprisingly easy to keep the air saturated: hang wet sheets all around and keep them wet; or get hold of an old wall tent and play a hose on it. In addition, sprinkle the floor.

The vast accumulation of material on early work in the field of photo-cell applications which this book presents is, of course, a great aid against avoiding repetition of developments already made. It struck the reviewer, however, as being of even far greater value, because in studying this book, much is to be learned of the way in which early, initial, devices can be made the beginnings of much more elaborate applications to come. Thus the Reis selenium relay diagrammed in Fig. 150 is not a far cry from what later formed the basic element of an automatic ship-control device (the Grindell Mathews control cited on page 201).

In this respect the book is especially valuable to those working on industrial control applications of photo-cells. For one thing, photo-electric follow-ups for instrument pointer elements, is a field of development well under way (G.E. photo-cell recorder, Tagliabue photo-electric self-balancing potentiometer) and due for much greater developments. Then also, the photoelectric control of furnace temperature by radiation measurement has yet to begin. Yet in this book are presented devices already old, which afford the rudimentary elements for applications in this field. These are the many photo-cell photometers mentioned, particularly the "density meter" of Fig. 196, which needs but slight modification to become a wedge (comparison) type photoelectric radiation pyrometer.

Altogether, this is a book only for workers in the photoelectric field. But to workers in that field, particularly to those interested in applying photoelectric methods to making advances in industrial control, it is a book well worth having.—H. Ogden (5.4)

Photoelectric Phenomena. Arthur Llewelyn Hughes and Lee Alvis DuBridge. McGraw-Hill Book Company, Inc., New York, 1932. 6¼x9¼ inches. 531 pages. Price $5.00.

Contributions to photoelectricity have been so numerous during the past decade that a complete survey of the art up to the present time is welcome indeed.

Research workers in photoelectricity will find this book an indispensable reference. The works of over 600 experimenters are mentioned in more or less detail. It will be of great benefit also to others who desire to enter the field of photoelectricity and who are qualified to make a serious study of the subject. The authors have presented not only a complete compilation of the efforts of investigators but also an interpretation of the results, with a view of explaining the fundamental laws underlying photoelectric phenomenon. In this manner, for example, the validity of the Einstein photoelectric equation, regarding light as made up of tiny corpuscles or quanta as against the classical wave theory is strikingly shown to the satisfaction of the reader.

The first portion of the text deals with the emission of electrons from metallic surfaces. Ionization of gases, photo-conductivity in solids, photo-electric effects in liquids and insulators and of X-rays and gamma rays are discussed in later chapters.

Of particular value to the experimenter is the chapter on photoelectric technique in which information—not usually found in such summarized form—is given about the design, preparation, and the use of photoelectric cells, etc.

A discussion of the uses of the photo-electric cell in industry and in the laboratory and an appendix of units and definitions complete this highly authoritative book.—N. Nazar (5.3).

◆ ◆ ◆

Paul F. Hermann Company, 1910 Beechwood Blvd., Pittsburgh, Pa., has taken over the exclusive representation of Federal Products Corporation, Providence, R. I., for Western Pennsylvania and West Virginia for dial indicators and gages.

MANUFACTURERS' LITERATURE

In this department we each month list the printed matter issued by manufacturers. Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter are invited to do so.

A99 **Sprinkler Watchman.** Booklet issued by The Gamewell Company, Newton, Mass., describes supervisory device connected directly with the fire department through a Gamewell Master Fire Alarm Box.

A100 **Lathes and Attachments.** Catalogue No. 93 describes the entire line of South Bend Lathes, together with various special attachments, grinders and tools. South Bend Lathe Works, South Bend, Indiana.

A101 **Tangent Meter.** A circular describing a simple device for the direct measurement of the tangent to a curve at any point. Bausch & Lomb Optical Co., Rochester, N. Y.

A102 **Comparison Microscope.** A 13-page booklet issued by the Bausch & Lomb Optical Co., Rochester, N. Y., describes a comparison microscope that offers an easy logical method of making detailed comparisons.

A103 **Recording Thermometer.** Bulletin No. 169-1 contains many new features and additions, among them descriptions of the Anti-Ambi Thermometer, the Self-Contained, Portable Temperature Recorder, and the Rotax Controller. The Foxboro Co., Foxboro, Mass.

A104 **Optical Tools for Inspection and Testing,** is the title of a reprint from *Machinery*, issued by Adam Hilger, Ltd. 98 King's Rd., Camden Rd., London N.W.1, England.

A105 **Dynamic Weigher.** A circular describing a new scale which determines the mass of an article or commodity by measuring inertia while it is in motion. Toledo Precision Devices, Inc., Toledo, Ohio.

A106 **Taylor - Rochester.** Among the articles featured in the January 1933 issue are—"Science Surveys the Clouds"; "Solving the Mystery of Yellow Snow"; "Hygrometry"; etc. Taylor Instrument Companies, Rochester, N. Y.

A107 **Gothic Lettering.** Bulletin No. 101 describes Wrico vertical gothic lettering set. Warren-Knight Co., 136 North 12th St., Philadelphia, Pa.

A108 **Experimenter.** "Mixer Controls for Dynamic and Ribbon Microphones" is the feature article of the February 1933 issue. General Radio Co., Boston, Mass.

A109 **Flow Meters.** Bulletin 189 describes and illustrates bell-type meters for low pressure gas flow measurement. The Foxboro Co., Foxboro, Mass.

A110 **The Graphic.** Bulletin No. 233 contains an editorial on Technocracy. Esterline-Angus Co., Indianapolis, Ind.

A111 **Ohmite News.** The February 1933 issue contains the usual interesting engineering data. Ohmite Mfg. Co., 636 N. Albany Ave., Chicago, Ill.

A112 **Acid Alkalimeter.** A circular describing an instrument which determines pH directly, continuously and automatically. Palo-Myers, Inc., 81 Reade St., New York.

INSTRUMENTS, 3619 Forbes St., Pittsburgh, Pa.

Please have me supplied with a copy of each piece of Manufacturers' Literature listed below.

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liquid level from the lower to the upper gage mark thereby transferring 1 cu. ft. of air or gas from the bottle to the apparatus being calibrated, or the procedure may start with the bottle filled with liquid and drawing 1 cu. ft. of air or gas from the prover or test meter.

Moving Tank Type

In this type, the bottle is likewise immobile and similarly fitted with upper and lower gage-glass necks. A rubber tube connects the bottom of the bottle to the bottom of a reservoir vertically movable between adjustable stops by means of a crank, sprocket and chains.

Fractional Cubic Foot Bottles

Of these, the 1/10 cubic foot bottle is the most importantly and widely used. It is of the moving tank type but simpler than the cubic foot size just described (two adjustable shelves serving to hold the tank in its upper or lower position), easy to use, and so inexpensive that one should be procured wherever one or more positive gas meters are expected to register small flows accurately. In the American Meter Co.'s model, the air with which the bottle is filled is bubbled through water in a "saturator bottle" in order to minimize some of the errors occurring when working in ordinary atmosphere.

Portable Cubic Foot Standard

This instrument's design resembles that of a gasometer of the annular type. The bell is sealed with water or—preferably—oil, but its travel is exactly limited by two adjustable stops of which one is closely adjustable so that the bell's displacement is adjusted to exactly 1 cu. ft. The standard can then be officially sealed in such manner that the adjustment cannot be changed without breaking the seal. The annular space is narrow, so that the oil attains ambient temperature a few minutes after the instrument is set up on location; but this tank is enlarged at the top, so as to minimize variation of oil level and consequently of the pressure of the contained air or gas. This portable standard weighs under 60 lb and may be shipped (in a suitable case) without risk of damage. When it is used to calibrate a bell type prover, the ordinary prover pressure may be used—which is not always possible when the immersion type bottle is used for that purpose.

(d) Gasometers, Test Holders, Bell Type Provers

The term gasometer is applied to gas holders of many sizes and of varying design and construction, but principally to those consisting essentially of a liquid-sealed bell. Those used merely for storage need not be discussed beyond mentioning that some are commercially available for test work where gas must not be contaminated. The suitability of a holder for gas measurement work depends not only on proper sealing with minimized liquid surfaces in contact with the gas, but on various features such as pressure-control counterweights, on various appurtenances such as U-tube gages, thermometers, quick shut-off valves, etc., and on the degree to which volume, pressure, temperature and humidity can be measured and controlled. As was made plain in the foregoing remarks on cubic foot bottles, errors may result from conditions outside the measuring apparatus. Gasometers commercially available for measurement and calibration work are so designed and constructed that (1) inherent error sources are minimized and (2) the effects in variations in external conditions are likewise minimized. Thus, accurate work can be done without call on high skill and without taxing endurance. The highest development of gasometers is represented by what is called for short the *meter prover*—though actually there are several makes and various models of these bell provers—other meter provers being designated specifically as flow provers, etc.

Bell provers are regularly manufactured in 2, 5, 10 and 20 cu. ft. capacities. Larger sizes are made to order. In determining the size needed, consider first which of the positive gas meters maintained by your department are to be brought in to your proving room periodically. (Most large meters can be proved by your department on location.) Next, take the volume represented by one revolution of the proving circle on the register of the largest meters to be proved in your proving room. This will give the minimum prover capacity. If, however, the largest meters to be brought in are to be tested by observing shaft revolutions, take at least four times the volume of one revolution as the required prover capacity.

Fig. 22-57 shows a standard prover, of the open-bell model favored in the United States, made by the Pittsburgh Equitable Meter Co. Two enclosed-bell models are also in use, the virtue of this design being reduction of temperature gradients—which advantage, in our opinion, is more than offset by inaccessibility of parts, higher costs, etc.

The Engine Indicator

(Continued from Page 96)

flashes. When taking a measurement the controlled air pressure is increased until the flashes disappear and then the pressure is read on the Bourdon gage. In measuring compression pressures during motoring runs, variations in pressure from cycle to cycle are so small that only one measurement need be made. When the engine is

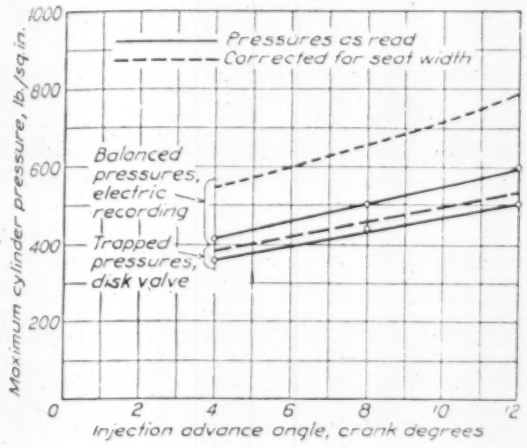

Fig. 108. Comparison of the cylinder pressure recorded by the disc valve of a Farnborough indicator when used (1) as a balancing valve with electrical recording, and (2) as a trapping valve.

running under power, maximum cylinder pressures usually vary somewhat from cycle to cycle and they are therefore expressed as a pressure range rather than as a definite pressure.

The balanced valve type of indicator can also be used as a non-return valve and the readings obtained by means of the entrapped cylinder gases instead of the outside pressure source. Experiments showed, however, that this method does not give as high readings for the maximum pressure as when using an extraneous pressure air source. A certain amount of pressure drop takes place when the cylinder gases pass the valve. The difference resulting from this error source is charted in Fig. 108.

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Control of Fractional Horsepower Motors

(Continued from Page 94)

switch opens all the motor leads when in the "Off" position. With d.c. motors, however, this switch opens only one side of the shunt field. Where the motor is to be used with a limit switch for each direction, this drum can be supplied with 8 fingers, connected as shown in Fig. 17. Upon opening of either switch, the motor can be moved away from the open limit by throwing the drum lever to the opposite position.

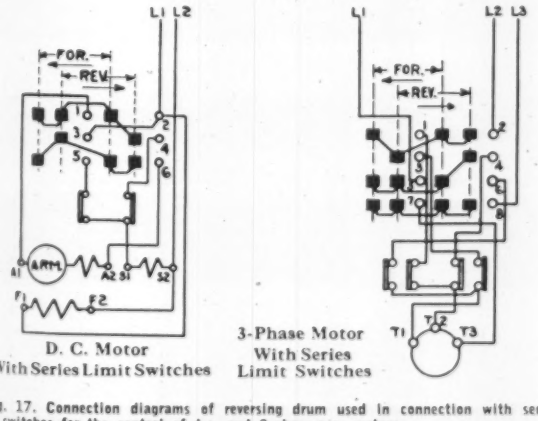

Fig. 17. Connection diagrams of reversing drum used in connection with series limit switches for the control of d.c. and 3-phase a.c. motors.

Used with ballast resistors to reduce the starting current and equipped with spring-return handles, these small reversing drums are used in connection with lathes for controlling cross-rail, tail-stock, and tool-traverse motors, which are operated only intermittently.

The reversing switches thus far considered do not provide overload and no-voltage protection. Overload protection can be obtained by inserting overload breakers in the motor circuits. No-voltage protection, however, cannot be obtained on manually operated switches without using a magnetic switch as auxiliary equipment.

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Elihu Thomson, Director of the Thomson Research Laboratory of the General Electric Co., at Lynn, Mass., and "Dean of Electrical Engineers," was honored by numerous scientists, engineers, educators and public men at a dinner on March 29, his eightieth anniversary. The dinner, held at Massachusetts Institute of Technology, broadcast over many stations, and presided over by President Karl T. Compton who, among others, pointed out how the electrical industry and other modern developments were influenced by the genius of Thomson, who holds more than 700 U. S. patents—the second largest number held by any living man. Thomson has been an electrical pioneer both in practical and theoretical things. He had one of the best of the early arc-light systems. He invented the first 3-phase electric dynamo. He was the first man to use transformers on electrical circuits in the modern manner. He discovered the secret of electric resistance welding. He had the first practical watt meter. He pioneered with his lightning arrester and his alternating-current motor. As a boy, he demonstrated wireless waves twelve years before anyone else.

He learned how to grind a microscope lens, and before he was 20 he built a complete microscope, containing ten lenses, the largest not as big as a nickel and the smallest about the size of a pin-head. He became interested in color photography and has today a whole cabinet filled with auto-chrome pictures of New England autumn foliage. At 20, Thomson was an assistant professor in the Boys' Central High School of Philadelphia, a high school with almost a college rating. He was only 23 when he was appointed full professor of chemistry and mechanics. In this same period he lectured at the Franklin Institute on the nature of electricity, making original experiments on the platform. Interested in astronomy from his earliest manhood, Thomson has always had his own observatory and small telescope, the lenses of which he has ground himself. Nearly 35 years ago he first suggested the use of fused quartz for the mirrors of reflecting telescopes. Today fused quartz is being seriously considered for the mirrors of the great 200-inch telescope to be built for the California Institute of Technology. Jointly with his first colleague, Professor Houston, Thomson invented and patented the continuous centrifugal cream separator in 1877 to 1881. In 1903 he patented a non-condensing reciprocating engine which became the "uniflow" engine. In 1914 he invented a speed indicator utilizing the liquid drag principle, and a hydraulic clutch mechanism.

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The Neilan Co., Ltd. (Division of Mason Regulator Co.), announce the opening of a new office in Baltimore, Maryland. O. H. Seal, an engineer with several years' oil and control experience, will be in charge of this office which will be located in the Whitaker Building. Mr. Seal will serve the Baltimore territory with Neilan regulating equipment and Mason-Neilan compensated temperature, pressure and flow control instruments.

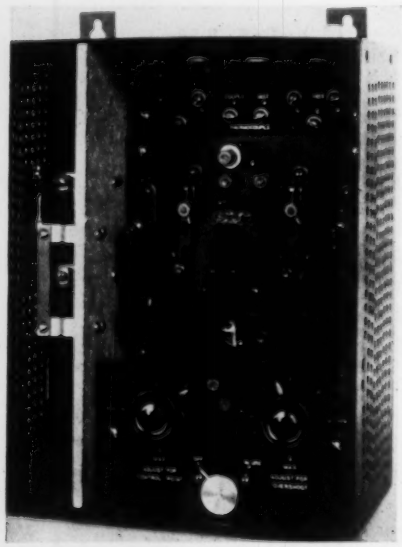
NEW INSTRUMENTS

Write Information Section, Instruments Publishing Company, for additional Information.

Anti-hunting Device for Pyrometric Control

The Foxboro Co.

ELIMINATION of hunting or over-control is made possible by the "Deoscillator," a new auxiliary device which need only be "cut-in" between a thermocouple and a controller. Its particular function is to impress into the thermocouple circuit a slight additional e.m.f. that augments the thermocouple e.m.f. when the temperature is below the control point and opposes it when the temperature is "high." The effect of this selective action is to cause the control instrument to "anticipate" the return of normality, and hence to prevent "overshooting." Thus, on a rising temperature, the heat input is decreased (by turning off a valve, switching off electric current, etc.) at a temperature slightly below the desired control temperature set on the instrument, and conversely, on a falling temperature, heat is increased when a temperature is reached that is slightly above the instrument setting. By using 2 simple adjustments provided for the purpose, it is said that the Deoscillator can be adjusted to such close control that a separate and independent recorder, and thermocouple in or near the work, will draw practically a straight line. Installation is very simple. Since the correcting or anticipating action of the Deoscillator is entirely adjustable, to whatever values may be required, it is applicable to 2-position control systems regardless of (1) type of thermocouple used, (2) make of control pyrometer, and (3) operating temperature. The Deoscillator operates in conjunction with any of the electrically operated valves, magnetic contactors, relays or similar regulating apparatus ordinarily used with 2-position or 3-position pyrometer control systems. In many cases where 3-position control is in use, control can be improved by changing the system to 2-position and applying the Deoscillator. The change is a simple one and is accomplished by connecting 2 of the 3 control positions together, electrically, at the control pyrometer. If a true temperature record is desired of a control operation governed by the Deoscillator, the temperature should be recorded on a separate recorder. The Deoscillator corrects control conditions arising from temperature lag, and it is therefore applicable not only on new control installations but also for systems already installed and in use, where the troublesome effects of lag have not yet been conquered.



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Visitron F-2 Photo Cell

G-M Laboratories, Inc.

A NEW photoelectric cell, designated as Visitron Type F2, which requires no battery or other source of voltage, is suitable for use with meters for light intensity measurements, or with sensitive electromagnetic relays without vacuum tube amplification. The sensitive disk in the F2 cell is mounted in a sealed metal case 2¼" in diam. and 7/16" thick. Terminal studs for electrical connections and mechanical mounting project from the rear of the cell to facilitate its use in manufactured assemblies, instruments or experimental work. A characteristic of the new cell is the high current produced at low light levels, the current response being substantially linear for low values of illumination and with low external circuit resistance. In respect to its high current output, it is said to excel other similar cells by a considerable margin.

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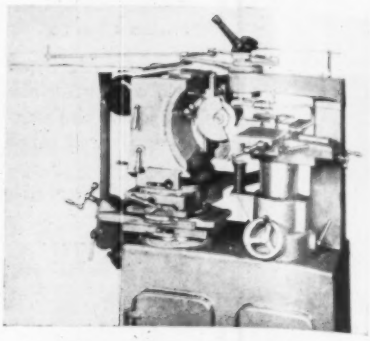
Hot Wire Time Delay

Struthers Dunn, Inc.

DESIGNED for applications where a short time delay interval with rapid, but not immediate recycling is required, this bow type hot wire time delay, in conjunction with relays, can be used to secure either delayed opening or delayed closing. It consists of a hot wire member, a bow member, and two adjustable, fixed contacts, all mounted on a 7"x3" base of insulating material. When current flows through, the wire elongates, and allows the bow to straighten. The contacts are single pole, double throw, and the bow member carries the moving contact from one fixed contact to the other. Contacts are rated to carry and break 2 amp. at 110 volts, a.c. or ¼ amp. at 115 volts, d.c., noninductive load. This unit is designed for delays from 1 to 5 seconds; the time of cooling is proportional to the time of heating up. It is compensated for changes in temperature and has an accuracy of approximately ± 10% dependent on constant current supply. Changes in timing can be accomplished by altering the position of the adjustable fixed contact members.



Naumann Profile Grinder

George Scherr Co.

WITH this machine it is possible to finish grind the work after hardening or to work directly from the solid piece, either hardened or soft. The principle employed is the use of a 50-times magnified drawing, from which the contour is reproduced through a pantograph which governs a hairline cross in a Zeiss microscope through which the work is observed under 10× magnification.

Mounted on a sturdy, box-shaped base are 3 units: the grinding wheel head, the work slide, and the pantograph with microscope and drawing board.

In the grinding wheel head wheel spindle is provided with a reciprocating stroke, up and down, adjustable and 2 speeds. The head swivels in 2 planes so that forming tools with different rakes can be produced. The work slide movement is limited by stops so made that standard gage blocks can be inserted, and dial indicators used.

The maximum range of work on the machine is 6" by 2 9/16". The stroke of the grinding wheel is 2", so that work pieces up to about 1⅞" thick can be ground. A complete dust exhaust system, including air filter and individual motor, is provided.

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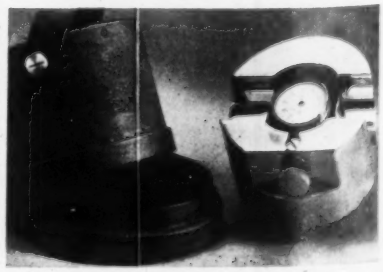
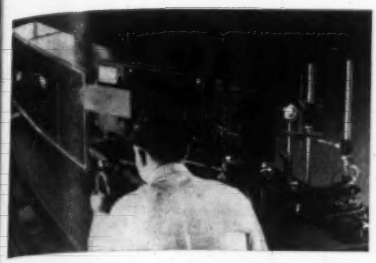
Portable Vibrometer

Starrett Co.

FOR power plant, field and service work, and for general testing, a new compact vibrometer is announced by the above company. It consists of a flexibly supported mass, and a dial indicator fastened to the end of a thumb screw and supported by the mass, to measure the amplitude. Vertical movements are measured with the adjustment shown in the photograph, but for indications in the other 2 principal planes the dial indicator is turned through 90°. Laboratory tests show that the vibrometer is reliable for frequencies as high as 6000 r.p.m. when the amplitude does not exceed 0.004", and at lower speeds for much higher amplitudes.





Large Littrow Spectrograph

Bausch & Lomb Optical Co.

THE NEW Bausch & Lomb Littrow type spectrograph was primarily intended for use in the analysis of steel and other materials yielding extremely complicated spectra containing many lines, separated by small wave length differences. This made it necessary to build an instrument of large size, in order to secure the necessary separation of lines on the photographic plate. With this instrument even the most complex spectra are effectively resolved and dispersed. This permits accurate work, both qualitative and quantitative, with alloy steel, tungsten carbide alloys, stellite and other materials yielding spectra in which the lines are so crowded together that an instrument of smaller linear dispersion cannot be used satisfactorily. At the same time it is admirably suited to the analysis of materials whose spectra are relatively simple.

The instrument is named for Dr. Ovon Littrow, the Polish physicist, who first used the autocollimating type of optical system in a spectroscope (1863). Its characteristic feature is the use of a reflecting surface on the back of the prism to reflect the dispersed light back through the prism and lens, the latter serving both to collimate the entering light and to focus dispersed spectrum on the photographic plate. This makes it possible to build an instrument ½ length that would be necessary in order to get an equivalent distance between the slit and the photographic plate and requires but half the amount of expensive optical quartz that would be required with the more conventional arrangement.

The Littrow Spectrograph is of heavy, rugged construction to insure rigidity and permanence of alignment and adjustment. It is very convenient to use and the optical performance approaches perfection.

A glass optical system is available, interchangeable with the quartz, which gives a still wider separation of lines between 3550 A.U. and 8000 A.U. This portion of the spectrum will cover 2 ten-inch plates. The linear dispersion of this system is about twice that of the quartz optics at the same wave length. It will be found particularly useful for studies in the visual portion of the spectrum, in which lie the most important lines of the alkalies, the alkaline earths and a few other elements.

A complete series of adjustments permits change in slit width, slit length, position of the spectrum on the plate, angle of the plate with the light beam, etc.

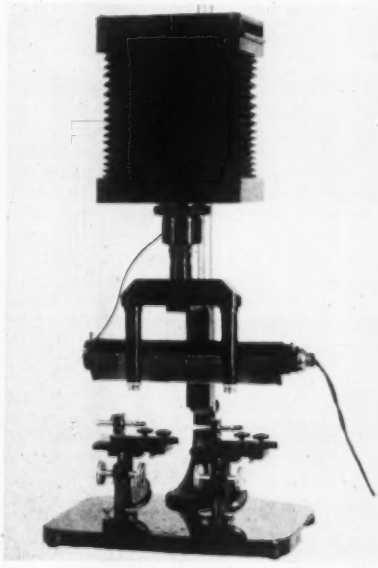
The entire mechanism is enclosed in a case of sheet metal. It is of unusually large proportion. This large size has been found to be the most effective means of providing for the deflection and absorption of stray reflected light, insuring clean plates free from the fog and light streaks.

Large Comparison Microscope

Bausch & Lomb Optical Co.

ESPECIALLY designed to permit the worker to determine points of similarity or dissimilarity between 2 objects, by being able to observe their magnified images simultaneously in a single microscope field, this instrument meets the requirements of the criminologist for examining bullets, shells, handwriting, fingerprints, and of the industrial worker for examining paper, textiles, crystals, printing, lithography, food stuffs, or in fact any microscopic material calling for the use of low magnification where the close comparison of two objects is essential.

The apparatus consists of 2 microscope tubes and a comparison eyepiece, built as one unit, for comparing objects held on 2 completely adjustable stages. This instrument gives magnifications of 5, 10 and 35 times. A camera is available for photographing objects that are under comparison. A single lamp 12" long, equipped with a daylight filter, is used to flood both stages with uniform illumination. The camera takes 5 x 7 plates and is so constructed that it is easily swung around over the eyepiece after the object has been properly located by the visual method.



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New Power Plant Instruments

The Brown Instrument Co.

REMOTE READING VACUUM-PRESSURE GAGE

THIS new instrument is made in the standard 12" circular case in indicating or recording types. Several instruments may be used in parallel. The transmitter is a mercury manometer so designed that it will operate above and below atmospheric pressure. A range commonly employed is 30" of mercury vacuum to 15 lbs./in.² pressure. By means of the Brown Inductance Bridge, the movements of the transmitter are conveyed to the indicating or recording instruments which may be located miles away. Hotel, apartment, and office building heating systems are among leading applications.

BOILER WATER-LEVEL METER

OPERATING on the same principle as the gage mentioned above, this instrument also employs the Brown inductance bridge as a transmitting means not affected by variations in voltage or frequency encountered in commercial 110-volt 60-cycle circuits. This meter does not displace the well-known gage glass. In most cases the transmitting manometer is connected in parallel with the gage glass. The indicator or recorder may be placed in any convenient location and an indicator and a recorder may be used in parallel. This combination is frequently used with an indicator on a boiler operator's panel and a recorder in the chief engineer's office.

Both the vacuum-pressure gage mentioned above and the boiler water level meter can be supplied with control contacts which may be adjusted to control to a certain point or they may be set to control within maximum and minimum limits. These control instruments use mercury switches that will make and break 25 amp. a.c. on 110 volts.

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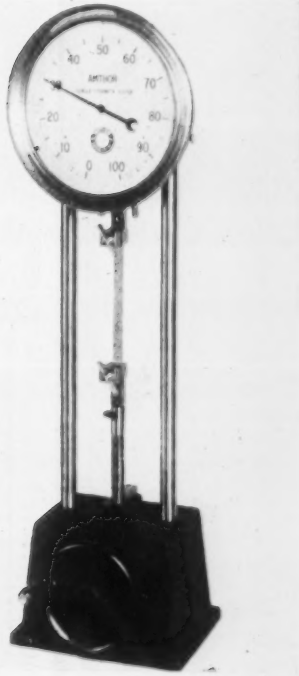
New Tensile Strength Tester

Amthor Testing Instrument Co., Inc.

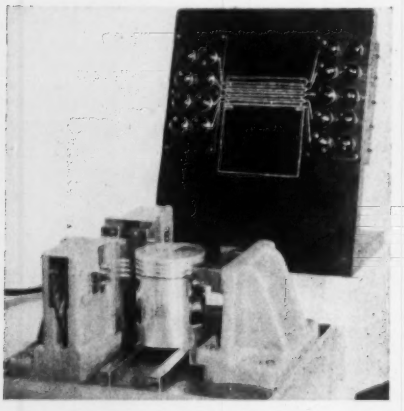
SUITABLE for a wide variety of materials, a new tensile breaking strength tester has just been designed by the above company. Accuracy, simplicity of operation, and rapidity of test are features stressed. The dial, 8½" in diameter, graduated in fractions of either pounds or kilograms, is hand calibrated. The dynamometer spring movement is specially designed for tensile testing and is so constructed that proper test sensitivity and elimination of friction are assured by free-floating movement throughout. When the specimen breaks, the pointer remains at the tensile strength reading. Jaws and jaw travel can be had in conformity with standard test methods for any material such as paper, cordage, wire, etc.



Gaging Several Diameters Simultaneously

Pratt & Whitney Co.

AS shown in the illustration the new Electrilimit gage is arranged to check 9 diameters on an automotive piston, 5 of these dimension are outside diameters, and 4 are groove diameters. Checking is done by means of electric contacts arranged to engage the desired surfaces as the piston slides through. When the part is within all desired limits, no lights appear on the indicating board; if any dimension is oversize, the corresponding green light flashes on; if undersize the red light appears. This gage has cut inspection time approximately 65%: 864 pistons per



hour as against 288 previously, a ratio of 3 to 1; there is a definite increase in uniformity and quality of inspection; a less skilled inspector is used on the job —all this is because the new gage eliminates the human element factor: The lights either flash or do not flash, and the work is graded accordingly. This type of electric gage makes it possible to hold limits closer than usual, and yet obtain entirely satisfactory gaging at high speed. It can be applied wherever one or many dimensions are to be gaged. Its general appearance will change for different jobs, but not its fundamental principles.

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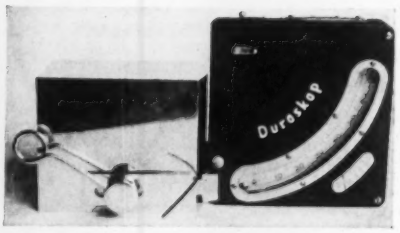
Wire Hardness Tester

R. Y. Ferner Co.

A SPECIAL form of the Duroskop, for testing the hardness of wire and other cylindrical material of small size, is announced. Hardness is measured by the angle of rebound of a falling pendulum. The usual spherical anvil of the pendulum hammer head is replaced with a cylindrical anvil the axis of which is parallel to the pendulum rod; accordingly the side of the cylinder strikes across the wire being tested when the latter is held in a horizontal position.

Rapid routine tests of wire are possible with this instrument, even with the wire in motion. For such tests an 8-lb. block, with all parts chromium plated, has been designed. It has one end curved on a radius of 3¾" while the opposite end is flat, suitable for the test of straight material such as drill rod, needles, etc. 2 adjustable supports for the wire or rod are provided, having notches for holding the wire against the curved



surface during the test. For wire to be tested while being unreeled, holes can be provided in these supports through which the wire can be passed at the proper level. The supports can be reversed or inverted, for use at the opposite end of the block or for special forms of material to be tested.

The Duroskop itself is entirely self-contained in a case 4⅛" square and 1¼" thick, the whole weighing 13 ozs. The equipment can be used for testing wires as small as 0.004" or for cylindrical objects as large as 2" diam. Black wire can be polished at the point of test or the difference between readings on the black surface and the polished surface can be determined and applied as a correction. Tinned wire or wire thinly coated with zinc by the galvanizing process give practically the same results as if there was no coating, but hot-zinced wire must be cleaned at the test point to avoid the effect of the zinc coating.

The suitability of material for rivets can be tested by the multi-stroke method: the Duroskop and the specimen clamped together for repeated readings at the same spot, and the successive readings then plotted to show which material shows the most rapid increase in hardness. The suitability of wire for drawing, coating, hard drawing or for nail heads, for binding wire, etc., can thus be determined quickly. The Wire Duroskop can also be used for testing the hardness of steel balls, as the cylindrical head can be made to strike across the surface of the ball. The blow leaves only a microscopic mark on the surface.

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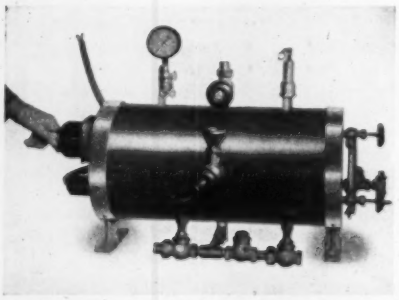
Laboratory Steam Generator

Commonwealth Elec. & Mfg. Co.

MINIATURE steam generators in 4 capacities from 6 to 15 lbs. of steam per hour have been announced by the above company. This new line is designed for use in testing laboratories and wherever it is desired to provide small quantities of steam at high or low pressure whenever (and only whenever) needed. Heat source is a G. E. Helicoil element; welded steel shell conforms to A.S.M.E. code; steam is avail-



able from cold within 20 minutes after snapping on the 3-heat switch; condensate may be piped back at special connections; insulation is 85% magnesia and finish is Duco; running costs are said to be surprisingly low.

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Thermostat for Water Vapor

Barber-Colman Co.

A CORROSION-RESISTANT, low voltage, 3-wire, duct thermostat for use where exposed to water vapor is announced. All parts exposed to the vapor are made of phosphor bronze, with the exception of the bimetallic thermal element. Models are now available in the standard ranges. In general appearance this new instrument resembles the regular Barber-Colman duct thermostat.

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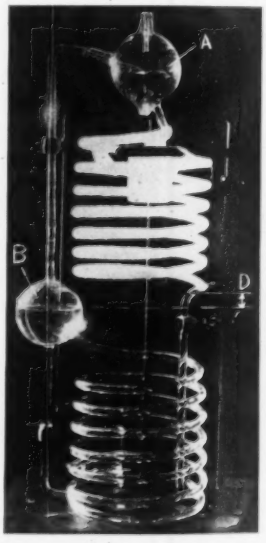
Instrument Man's Miniature Power Plant Draws Power Show Crowds

AN unusually powerful attraction to engineers and layman visiting the recent Power Show in New York is shown in the adjoining annotated photograph. The idea of George H. Gibson of the Cochrane Corp. in whose booth it was displayed, this miniature power plant included a turbine (A) which was revolved continually by a jet of vapor from the steam drum (B) of a coil boiler heated by the surrounding air. The "secret" of

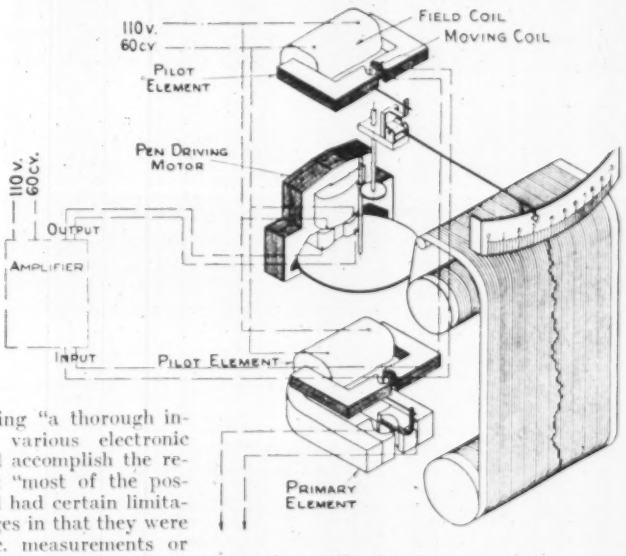


constant operation was that this air not being saturated, it simultaneously cooled the condenser coil (surrounded by a moistened wick) to wet-bulb temperature, the assumed differential being 10°F. The upper end of the condenser wick was immersed in a cup of water to keep it moist; the outer surface of the boiler was kept dry. The resultant difference in boiler and condenser steam pressures was 1 in. water column, observable as the differential (D) between boiler inlet and boiler drum water levels. The "jet h.p." was 0.000016 and the Rankine cycle efficiency an even 1%.

Null-Method Recorder Uses Electronic Amplifier

Westinghouse Elec. & Mfg. Co.

NEW in its principle of recording, and possessing characteristics heretofore unattainable, this strip-chart instrument nevertheless consists of time-tried elements all of which, individually, use known principles. Accepting the challenge of the ordinary home radio receiver which picks up an infinitesimal amount of energy and amplifies it to concert volume, H. L. Bernade and L. J. Lunas interposed an electronic amplifier between a highly sensitive primary element and a powerful chart - writing mechanism in such a way that the rugged pen follows the primary pointer as instantly as a shadow and—as in the case of a shadow — without imposing any drag on the delicate pointer. This idea in itself is not new but Bernade and Lunas after conducting "a thorough investigation of the various electronic methods which would accomplish the result," concluded that "most of the possible methods studied had certain limitations and disadvantages in that they were either limited to a.c. measurements or made use of photocells, optical systems, or contacts which require maintenance or have certain limitations as regards ambient temperature."



The new method finally devised by Bernade and Lunas depends upon the use of an *additional* coil mounted on the moving element of the measuring instrument. (This coil does not add any appreciable work for the measuring element to perform; therefore, the accuracy or the torque requirement is not changed.) This coil is used as a detecting or pilot coil and is placed in the field of a stationary a.c. electromagnet. The object of the pilot coil is to detect the position of the measuring element with respect to the electromagnet. A *duplicate* of this coil is mounted on the recording mechanism and arranged to operate in the field of a *similar* electromagnet excited from the *same* a.c. source. The relative position of these pilot coils is compared and controlled by their *relative* action on an auxiliary circuit. The current in this auxiliary circuit is amplified to give power sufficient to drive a high torque pen driving element.

The electronic recorder consists essentially of:

1. The primary, or measuring element which may be any usual type indicating instrument mechanism.
2. The pilot element attached to the measuring element.
3. The pilot element at the pen mechanism.
4. The motor element for driving the recording pen and for carrying the second pilot element coil.
5. An amplifier for furnishing reversible driving power to the pen motor.

Referring to the diagram herewith, the primary element is mechanically connected to a pilot element which comprises a moving coil mechanism rotatable in an a.c. fie'd. This field is provided by a stationary electromagnet connected to an auxiliary controlling circuit. The moving coil of this pilot coil is connected in series with the moving coil of the duplicate pilot element which is mechanically connected to the pen-driving motor. The stationary fields of both pilot elements are connected in parallel to the same a.c. source. The moving coils of the pilot elements are connected in series opposing each other. When these coils do not occupy the same relative positions in the a.c. fields, the voltages induced in the coils are not equal so that the output voltage at the terminals of the pilot moving coils is of a value depending upon the magnitude of this difference. This voltage is of the order of 50 millivolts per degree deflection. The output of these coils is connected to the grid of the amplifier tube of the power amplifier unit. The a.c. output of the amplifier is the same frequency as the pilot element excitation.

The pen-driving motor is essentially a 2-phase motor of which one phase is continually energized from the same source of power as the pilot element electromagnet coils. The phase position of the current in the other phase of the motor is determined by the relative positions of the pilot coils which determine the polarity and magnitude of voltage of the amplifier grid and as a consequence the a.c. output of the amplifier. With the second phase of the pen-driving motor connected to the amplifier output, the motor will turn in a clockwise or counterclockwise direction at a speed proportional to the difference in the pilot coil positions. This results in a proportionate response action of the pen motor.

"It should be noted" say Bernade and Lunas, "that this proportionate response action makes anti-hunting or special damping unnecessary as contrasted to the usual relay type recorder, and makes speed of response proportional to the deflection. This overcomes the difficulty of previous relay type recorders in which the speed of response cannot be made as great as in corresponding indicating instruments without introducing hunting . . . the action of the new recorder can be made as fast as that of the primary element."

The pen motor turns in one direction or the other until the difference in pilot voltages is zero, thus using a null method. Therefore, it is free from any errors which might result from aging or change in characteristics of the vacuum tubes which would result during their normal life. Usual decreases in emission or amplification factor result only in a decrease in the speed of response which is so small as to be unnoticeable for normal changes. Changes in control voltage within rather wide limits produce no noticeable effect. This is also true for changes in control frequency and wave form. Temperature changes produce no error. Stray fields affect both pilot coils equally so that no errors result. The additional energy required for the primary element to drive the pilot coils is that required to overcome the negligible torque of the conducting springs.

Under normal conditions it requires 1 sec. for the pen to travel from zero to full scale with an overshoot of approximately 2%. By increasing the time to 1.25 sec., the recorder can be made dead beat.

This instrument will record d.c. millivolts and microamperes at energy levels of 4 or 5 microwatts. A d'Arsonval mechanism in combination with a rectox rectifier makes possible the recording of alternating currents with full scale values as low as 0.5 ma. Alternating voltages can be recorded in the same manner with one volt full scale and a potential circuit resistance of 500 ohms per volt.

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Complete Assemblies for Air-conditioning Control

Julien P. Friez & Sons, Inc.

NUMEROUS combinations of room temperature and humidity sensitive elements, relays, transformers, etc., commanding solenoid water, gas, air and other valves, are announced. The parts are furnished already assembled, interwired and mounted in attractively finished metal knock-out type boxes with diagrams pasted inside the hinged lids. In some types the thermostat or "Humidistat" instruments are mounted on the outside of these lids. Fig. 1 is a view of such an assembly opened for inspection of the relay and transformer. In other types the temperature or humidity instrument is separately furnished for installation remote from the control assembly. Fig. 2 shows such a type, which is one of the assemblies incorporating a solenoid valve. This new line of control assemblies is for use wherever loads cannot be handled by the thermostat or Humidistat instruments.

Fig. 1

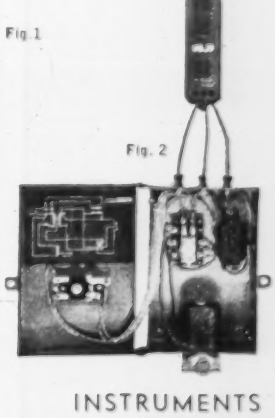

Fig. 2

Indicating Models of Control Potentiometers

Leeds & Northrup Co.

INDICATING controllers embodying the Micromax features of the recorders recently announced by the above company. These instruments are adapted for controlling various conditions in process industries, such as temperature, acidity and alkalinity (pH) of solutions, concentration, pressure, liquid levels, etc. The instruments are compact in construction. What is said to be a unique feature of both controllers and recorders of this type is the self-standardizing of the potentiometer circuit, whereby the instrument is made completely automatic.

The temperature controller can be adapted for unusually short or comparatively low ranges as well as the higher pyrometer ranges. The control temperature setting is indicated by a pointer on the scale, while another pointer follows the control action and shows the existing temperature. The potentiometer type of indicating controller, as used for automatic regulation of pH in process solutions, may have whatever range is required for the type of electrode most suitable for a given solution. For regulation of the concentration of solution constituents, the indicating controller has an alternating current Wheatstone bridge circuit for use with a conductivity cell in the solution.

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Self-Recycling Time Delay Relay

Ward Leonard Electric Co.

THE Agastat, a new self-recycling time delay relay for opening or closing a circuit at a predetermined time interval after the application of energy to the control circuit, employs a solenoid magnet moving a shaft by way of a spring. The shaft carries on one end a contact member and is restrained in its movement by the timing device.

Operation is governed by the transfer of gas between 2 adjustable chambers which are sealed to the outside air and communicate with each other through a small passage controlled by a check valve.

Adjustment of the timing is effected by adjusting the gas passage between chambers and remains fixed once the setting is made at the factory.

The time range is from 1 second to 30 minutes. Relay coils are wound for voltages up to 230 d.c. and 220 a.c. 25 or 60 cycle. The silver to silver contacts are rated at 2 amperes d.c. and 6 amperes a.c. The over-all dimensions of the Agastat are approximately $2\frac{3}{4}$"x$2\frac{3}{4}$"x$4\frac{11}{16}$".

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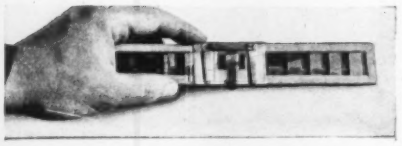
Wulff pH Tester

Pfaltz & Bauer, Inc.

PORTABLE to the extent that it can be carried in one's coat pocket, this new apparatus for determining quickly the pH of liquids and moist solids has also the characteristic that it works as accurately and easily in highly colored, turbid and viscous solutions containing suspended matter as in water-white soluble solutions, where most colorimetric methods fail. The apparatus can be operated by an efficient workman. It will give results in many cases where electrometric methods fail, such as with



oxidizing-reducing mediums, protein solutions, mediums which poison electrodes easily and in tests where only a small sample quantity is available. No solutions have to be measured or handled. Indicator strips (indicators absorbed in a water-diffusible membrane) are brought in contact with the medium to be tested, blotted and compared with the dry stable color standards of the same material as the indicator strips, mounted on easily handled glass slides. The tester reads accurately to 0.1 pH since standards are by intervals of 0.2 pH. The whole operation can be completed in 3 minutes.

Procedure—A small quantity of the material to be tested is placed in the Jena glass dish and with the forceps an indicator strip (½ of the strip is sufficient) of the approximate range is placed in contact with it. The medium is stirred by means of a glass stirring rod for the specified time (usually 1 minute) which is timed by the 1-minute sand glass. The strip has now changed its color to correspond to the pH of the test medium. The strip is blotted between 2 sections of the neutral blotter pad and compared with the standard slides using the sliding strip holder. The pH is read directly. Should the color of the strip fall beyond this range the next range is used. In cases where suspended matter adheres to the strip, the strip can be washed in distilled water before blotting. Colorless strips to compensate for the stain of certain dyes are available.

The Wulff pH Testers cover the pH range from 1.4 to 12.6. There are 6 sets of indicator strips and 6 corresponding standards as follows:

No. 0—pH 1.4 - 3.6	No. III—pH 7.0 - 9.0
No. I—pH 2.6 - 5.0	No. IV—pH 8.2 - 10.8
No. II—pH 5.0 - 7.2	No. V—pH 10.1 - 12.6

For slightly buffered solutions two ranges, No. Ia—pH 4.0 - 6.2 and No. IIa—pH 6.2 - 8.4 are available.

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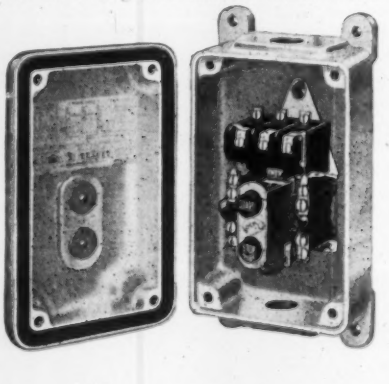
Hand-Operated Starter in Splash-Proof Cabinet

Allen-Bradley Co.

A SPLASH-PROOF, hand-operated starter for motors up to 3 h. p., 110 volts, 5 h. p., 220 volts, and 7½ h. p., 440-550 volts, has been added to this maker's line. The operating mechanism is identical to the standard hand-operated starter in which "start" and "stop" buttons operate the mechanism without a magnetic coil. Overload breakers disconnect the starter after sustained overload. The cadmium-plated cabinets are provided with rubber cover gaskets. Splash-proof push-buttons in the cabinet cover actuate the switch and exclude moisture from the switch mechanism.



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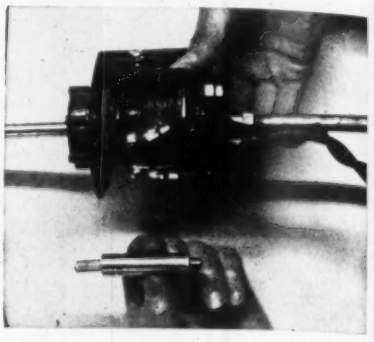
Solenoid Safety Fuel Valve

Westinghouse Elec. & Mfg. Co.

RECENTLY perfected by Westinghouse engineer L. G. Riley, a radically novel solenoid valve will find application on aircraft fuel lines and other locations requiring immediate closing on interruption of the energizing current. The non-magnetic tube on which



the coil is wound forms an integral part of the fuel line. The inner steel core normally seals the line, under the action of a spring. Only when the coil is energized does the core move to open the valve. Leakage is eliminated by flanged flare-tube joints. There are no stuffing boxes or gaskets. Beside its use on aircraft, the new valve is reported to be used on mercury arc rectifier vacuum pumps, to control steam flow to punch presses, and air flow to factory whistles.

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Motorized, Double Seated, Rotary Stem Lever, Control Valves

Minneapolis-Honeywell Regulator Co.

TO regulate flow of hot or cold water, steam, hot or cold oil, air, gas and other fluids, these motorized valves can be actuated by controlling devices produced by the makers or (in the case of "on and off" and "floating" control systems) by standard 3-wire controllers built by a number of instrument manufacturers. They can be functioned from float and time switches, manually-operated single-pole double-throw switches or remote push-button stations. The standard valves in both globe or angle pattern use the semi-balanced bevel-seated, or fully balanced wing guided inner cage construction. However they are available also in V-ported or Konevalv construction which eliminates any tendency to chatter or wire draw. Stuffing box, rotary stem, packing gland and other parts that come in contact with the fluid are made from forged stainless steel. The outer end of the yoke is fitted with a combination radial and thrust ball bearing which keeps the rotary stem in perfect alignment and reduces friction to a minimum. No internal ball bearings are used. Grease and vacuum seals for different services are available.

Power units comprise Minneapolis-Honeywell Industrial Motors designed upon a continuous duty rating basis and available in a wide range of timing. The massiveness of the bracket and linkage which connects the power unit to the valve contributes to the reliability of the assembly. Sizes run from ½" to 16" for 125 lbs./in.² working pressure and 500°F. safe temperature. Up to 4" size, a variety is available for working pressures of 900 lbs./in.² at 750° F.

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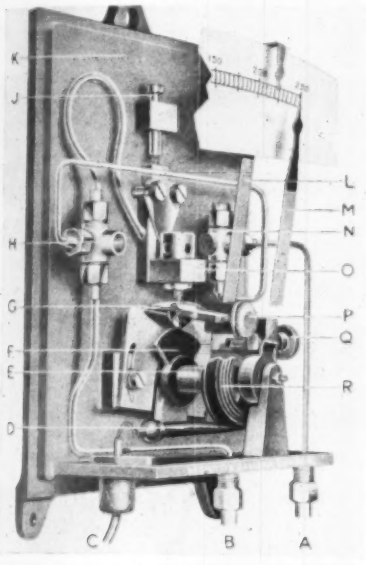
Air-operated Temperature Controllers

Negretti & Zambra

INDICATING and non-indicating models of automatic temperature controllers embodying a new construction of pilot air valve (or "air leak") are



A. Air inlet
B. Air outlet to control valve.
C. Capillary tubing to bulb.
D. Compensation for air temperature.
E. Axis carrying F. M. & R.
F. Cam operated by R.
G. Saddle piece pivoted support not shown).
H. Connection for pressure gage.
J. Adjustment for control valve sensitiveness.
K. Cast iron back.
L. Setting pointer controlled by Q.
M. Indicating pointer operated by R.
N. Air flow constriction.
O. Leak valve.
P. Balance weight for G.
Q. Adjustment for setting pointer.
R. Bourdon tube attached directly to E.

announced—the former in round cases and the latter in rectangular cases—all cases designed for wall or panel board mounting. Thermal systems are of the mercury-in-steel type, with minimized time lag. The distance from bulb to instrument may be up to 150 ft. without "tubing error" resulting from fluctuations of temperature around tubing. Temperature range limits are — 40°F. and 1200°F. A complete line of diaphragm-motor valves and other accessories is available.

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Slide-Wire Rheostats

G-M Laboratories, Inc.

TYPE R wire Wound Rheostats are particularly suitable wherever an adjustable resistor or potentiometer is required in a manufactured assembly such as radio receivers, audio amplifiers, or for laboratory equipment in which the apparatus is attached to a panel or chassis. The one piece construction of the molded porcelain form assures ample electrical insulation. The formed metal mounting bracket provides rigidity and a convenient means for mounting on metal, bakelite or wood. A single mounting hole is provided in each end of the mounting bracket.

Binding screws at each end of the winding permit the connection of any type R Rheostat as a potentiometer. The resistance wire has a low temperature coefficient of resistance and is tightly wound. An oxide coating on the wire provides ample dielectric strength to withstand the voltage gradient from turn to turn. When properly ventilated the maximum rated wattage dissipation is 75 watts. Considerable over loading for brief intervals of time will not permanently damage the resistor.

Both the slide bar and slider mechanism are of substantial construction and permit very easy adjustment. The adjustment screw is thoroughly insulated from the slider circuit, absolutely preventing shock or short circuit when adjustments are made. Positive contact between the slider shoes and the wire insures good electrical connection under all conditions such as severe vibration.

Every Type R Rheostat can be connected as a potentiometer.

Type R Rheostats can be furnished in 12 standard ratings, as follows:

Approx. Ohms.	*Max. Amps.*	*Approx. Ohms.*	*Max. Amps.*
5000	.12	140	.73
2200	.18	72	1.0
1100	.26	37	1.4
560	.36	18	2.0
270	.52	9.5	2.8
200	.61	4.8	4.0

Overall dimensions 7"x2½"x1½". Net weight ½ lb. Shipping weight 1 lb.

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Single and Double Slide-wire Proportioning Thermostats

Minneapolis-Honeywell Regulator Co.

ORDINARY room thermostats simply open or close circuits; these new instruments embody slide-wires and make use of the potentiometer principle. Consequently, they are for use only in combination with other units of "Modutrol" or "Proportioning" control systems whereby the valves or dampers under command are operated gradually. In each of the 2 new models a metal bellows is the thermostatic primary element which actuates a contact arm. Type T 92-1 Proportioning Thermostat incorporates a single potentiometer and Type T 92-2 Thermostat employs 2 separate potentiometer windings for operating 2 sets of separate proportioning control equipment. These thermostats are said to be simple, accurate in operation, and giving uninterrupted service. Internal parts are cadmium-plated. The Bakelite base is fitted with a detachable wall plate, suitably drilled for mounting on a wall switch box where wiring is run in conduit, or when desired, it may be attached directly to the wall surface. A key-operated locking device prevents removal of the cover by unauthorized persons and avoids tampering. These thermostats must be connected through an appropriate relay to function a proportioning power unit. This system is available only for service with a.c. applications. Temperature ranges 60-70-80° F. (standard); 40-50-60° F.; 80-90-100° F. Dimensions: height 5⅜", width 3⅛", depth 2⅞".

The Tour Supersensitive Electrical Relay

Lucius Pitkin, Inc.

ENTIRELY new in principle and characterized by high power control ratio, a novel type of relay has been developed by Prof. R. S. Tour, Univ. of Cincinnati, with the main object of meeting the demand for a universally applicable device intervening between any sensitive pointer-type primary or measuring element and almost any motorized valve, damper, or other final control mechanism or furnace-heating circuit consuming up to 3 KW. Other objects were extreme simplicity, durability, compactness, ease of adjustment without interruption of service, moderate initial and running costs, and the use of standard commercial neon tubes, condensers, transformers, etc., to keep down cost and facilitate replacement of accidentally damaged parts. Prof. Tour's development culminated in the construction and installation of several relays about a year ago. After a final development period, commercial production has now begun on relays with an available power control ratio of 5×10^{13}:1. That is to say, a variation of $< 5 \times 10^{-13}$ watt in the actuating circuit can make or break the 3 KW. power circuit. The sensitivity is adjustable at will from outside the relay cabinet, by turning a knob.

It is found in practice that a much smaller ratio suffices, because the available sensitivity makes it possible to control pressure, temperature, speed, flow, or other conditions within limits much smaller than those usually called for. In other words, by reason of the limitations of pyrometry, for example, when a metallurgist specifies that an alloy be heated to 2000° F., he has in mind 2000° ± 10° because he himself does not know whether 1890° or 2010° F. is the "one best" temperature, and it therefore is unnecessary to hold within ± 0.5° as is possible with a properly-installed Tour relay. Moreover, on many industrial control applications, the close regulation made possible by Tour relays would cause the controlled valves, dampers, switches, etc., to be operated more frequently than is desirable for many such devices.

The 5×10^{13}:1 ratio is developed entirely within one standard portable Tour relay unit embodying a rugged, inexpensive, double-pivot, relatively insensitive galvanometer.

The measuring circuit is external to the relay itself and may be of any standard design on the market today. The enormous sensitivity characteristic of the unit is obtained with a standard portable galvanometer, ordinarily of low sensitivity, when it is sensitized by the electrostatic attraction of charged "sparking tips" placed on each side of the zero position of the pointer. If the pointer tends to move but slightly to either side of balance position, *the sparking tip on that side attracts the pointer* into sparking position (not into any electrical contact). The ensuing spark carries negligible energy, but so excites an electrical circuit as to cause the latter to operate the main power relay.

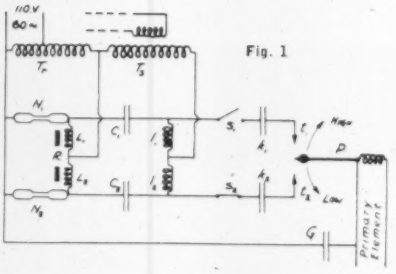
The Tour relay has within it no continuously or periodically moving parts, and requires no specially machined parts, precision adjustments, delicate assemblies, or calibrated variable resistances. No contacts are made or broken except

on the main power switch. Electrical power for operating the relay is supplied by plugging into a 110 volt, 60 cycle light socket, the current required being about 1 amp. The lead wires from the main power line, and the leads to motorized valves, heating elements or other devices to be commanded, are both attached to suitable binding posts. The relay power contacts in the unit are rated by the manufacturer for 40 amps. at 110 volts a.c., 30 amps. at 220 volts a.c., 6 amps. at 110 volts d.c. Operation is suggested at half these values. The complete unit with the power relay weighs 20 lbs. and is housed in a portable cabinet 12" by 9" (panel) by 6" deep, with a carrying handle.

Electrical Circuit. Aside from the potentiometric circuit ordinarily included, which circuit is external to but serves to actuate the unit, and aside from the power circuit which the unit commands, the Tour relay proper comprises 2 separate pairs of circuits, viz: (*a*) one pair of sparking (or control) circuits, and (*b*) one pair of relay (or work) circuits.

The 2 parallel *sparking circuits* are shown by *tPGNCSkt* on the wiring diagram, Fig. 1, and distinguished by subscripts 1 and 2. Transformer T_s impresses on these two circuits a 60-cycle high potential through chokes l and L. This high potential maintains condensers C of the sparking circuits charged at all times, these condensers discharging through either sparking tip t_1 or t_2 to the galvanometer pointer P, should the pointer move into sparking position. The sparking circuit that is operative, i.e. the spark tip through which discharge may occur, depends on which contactor, S_1 or S_2 is closed. When a spark passes from the charged tip t_1 or t_2 to the pointer P, the steep wave front or high voltage surge easily passes through the by-pass grounding condenser G to one of the electrodes of each of the neon tubes N_1 and N_2. The other electrodes of these tubes are separately connected through condenser C_1 and C_2, contactors S_1 and S_2, impedances k_1 and k_2, back to tips t_1 and t_2. Condensers C and k offer but little impedance to the voltage surge of the spark, the path of which is controlled by S_1 or S_2. Condensers k, while of high conductance for the spark voltage surge, are large impedances to 60-cycle current and therefore serve to limit the energy of the spark to the pointer-end and prevent all destructive arcing. The 2 circuits for the voltage surge are kept separated at their connections by chokes l and coils L which offer high impedance to the steep wave front of the spark discharge while offering low impedance to the 60-cycle charging current from transformer T_s. Thus when a condenser discharges through S_1 (or S_2) the voltage surge is constrained within the circuit 1 (or 2) in which it occurs and it is impressed across neon tube N_1 (or N_2) only. Such a surge ionizes the gas in the tube, giving it high conductance so that it will pass current in the relay (or work) circuit to operate the latch relay.

Each of the pair of *relay circuits*, shown as T_rLNT_r in Fig. 1, carries a moderate voltage available from a small auto-transformer T_r in the unit. This transformer is connected to supply current through either of the neon tubes, although the voltage is insufficient to pass current through either of the tubes excepting when they have been ionized



by a spark. One of the tubes is connected in the circuit in series with coil L_1 opening the latch of a standard latch relay switch R; the other tube is connected through coil L_2 closing the power contact-arm of relay R. When conducting, either tube passes more than enough current to operate its coil. These relay coils also serve as chokes between the sparking circuits to prevent interference between the tubes.

Should tube N_1 with its latch coil L_1 be caused to operate by a spark at tip t_1 on the "high" side of the galvanometer, the latch is withdrawn, the contact arm of the relay is allowed to open, and the valve-operating or furnace heating power is shut off; should the other tube N_2 and its coil be operated by a spark on the "low" side, the power contact-arm is pulled into place, then automatically latched and the current is on. The latch-relay serves another function also. The 2 armatures of this relay carry contact arms S_1 and S_2 so that when power is on, the "high" sparking tip t_1 is charged through S_1 (S_2 being open) to shut off the power, after which operation, S_2 is closed (S_1 open) and the "low" tip t_2 is charged, ready to turn on the power.

Sparking Galvanometer. The sparking tips t_1 and t_2 in the galvanometer are placed on the arc of motion of the pointer-end, one on either side of the zero position at which the pointer is to be maintained. Insulated stops are so placed as to make impossible a direct contact between coounter and sparking tips, although permitting a close enough approach for easy sparking. The pointer is grounded while sparking potential is supplied to one or the other of the sparking tips from transformer T_s.

Operation. Relay operation, by use of a spark rather than of a mechanical contact, has heretofore failed for one or both of 2 reasons, viz: (1) Because the sparking tips could not be placed closely enough to the zero position of the pointer to obtain necessary sensitivity without the electrostatic field around the electrified sparking tip either pulling the pointer out of position (hence making operation unstable) or causing inter-sparking between the 2 tips, (2) Because the spark discharge available for relay operation could not carry enough energy to operate any standard type of relay circuit, without burning the sparking tips and pointer-end.

In the Tour relay the first difficulty (i.e. with electrostatic fields) has been obviated, not by attempting to do away with the electrostatic fields but by so constraining or directing them as to make them serve a useful purpose, that of increasing enormously the sensitivity of the pointer-moving mechanism; be it electrical meter, gage, etc. This has been accomplished by so shielding and grounding the zone in the immediate vicinity of the zero or desired position of the pointer, that the field in this region from the electrified sparking tip will not cause sufficient force at the pointer-end to overcome entirely the resisting torque of the springs in the pointer-moving mechanism. By properly placing the sparking tips with respect to the shielded position of the pointer, the electrostatic force may be used to neutralize the spring torque to any extent desired, and so increase the natural sensitivity of the meter. As soon as the pointer is slightly displaced from its shielded position, in which it is entirely stable, it immediately comes under control of the electrostatic field which increases much more rapidly with pointer displacement than does the resisting torque of the springs. The pointer is now strongly attracted by and drawn to the electrified sparking tip where the desired spark will occur. Thus, an actuating force on the moving mechanism ordinarily sufficient to cause only thousandths of an inch pointer-end displacement against normal spring resistance may bring into play forces causing a pointer-end motion of 0.25" to 0.5". In this way the sensitivity of an ordinarily insensitive meter may be multiplied 50 to 100 times. Pointer P being drawn to one sparking tip rapidly comes into sparking position, a spark passes, a neon tube is sensitized, relay R functions, contactors S_1 and S_2 are interchanged, potential is removed from the active spark tip, and the pointer is immediately brought back to center by the full torque of the meter springs, ready to be attracted to the other spark tip which is now electrified. Since the meter spring torque may be completely neutralized by the electrostatic field acting on the pointer, it is evident that the only limitation to sensitivity is the static friction of the pointer-moving mechanism. It follows that for a control application where the e.m.f. variations, small as they are, are large compared with the sensitivities obtainable, the galvanometer used need not be an especially high grade instrument. Its springs need not be, in fact should not be, delicate. It is, however, desirable that the pointer motion be thoroughly damped in operation and that the static friction be small. A sensitivity of ± 50 microvolts may be obtained with the cheapest of standard galvanometers. The ± 10 microvolt sensitivity of the relay here described is obtained with an inexpensive standard galvanometer movement carrying a special low resistance (5 ohm) armature. The friction limitation to sensitivity on this instrument is about ± 5 microvolts. A sensitivity of ± 1 microvolt could be obtained with a critically damped, high torque-sensitivity, suspension movement.

The second difficulty with the use of a sparking galvanometer (i.e. insufficient energy in the spark) has been obviated by not using the energy directly to operate a relay but by allowing the voltage surge of the spark to sensitize a neon tube. An alternating rather than a uniform potential is used on the tube so that when the sensitizing voltage surges no longer exist, the tube will cease to pass current. A tube discharging for such short periods with comparatively long cooling intervals may safely carry 20 to 100 times the current ordinarily used for continuous operation in illuminating service; thus, in the Tour relay a tube ordinarily operated at 20 milliamps. delivers 1 amp. during sensitization. This is more than sufficient to motivate the solenoid-operated a.c. latch relay in series with the tube.

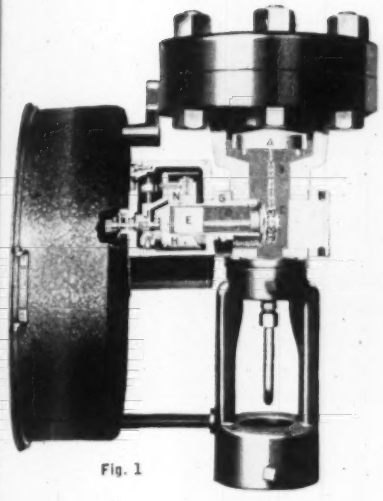


Fig. 1

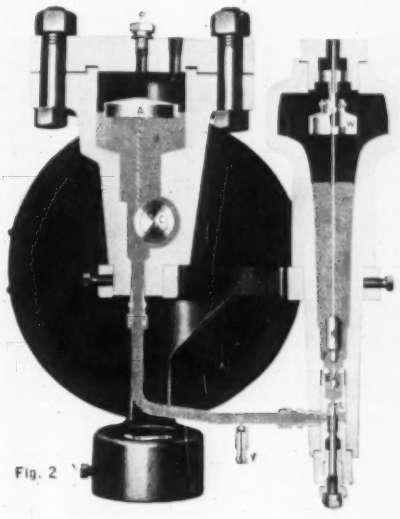


Fig. 2

Re-designed Flow Metering and Control Instruments

C. J. Tagliabue Mfg. Co.

OLD in principle but of new design and materials, a magnetic coupling does away with the usual pen-shaft stuffing-box in the new line of TAG flow instruments. This is not the first time a magnetic coupling has been employed in a differential pressure instrument, but whereas old forms employed "U" magnets and armatures with the lines of force in the gaps parallel to the axis of rotation, the new design is a radial coupling—as evident from the adjoining illustration. The angular position of rotor E is determined by the differential pressure. This rotor is within the pressure-withstanding portion of the instrument; the magnets are outside—exposed only to atmospheric pressure. Nevertheless, by virtue of the design, the gaps between the ends of E and the pole-pieces N and S are extremely small as compared to the cross-sectional areas of the rotor and of the pole-pieces. This combination of small gaps and large active areas is a consequence of the design whereby the rotor is located in a cylinder instead of on one side of a flat plate. Cylinder G (see Fig. 1) can withstand an internal pressure of 5000 lbs./in.² and yet its wall thickness is only 1/16 in. at the portion enclosing rotor E. Each gap, therefore, is 1/16 in. plus the small clearances between rotor and cylinder and between cylinder and pole-pieces.

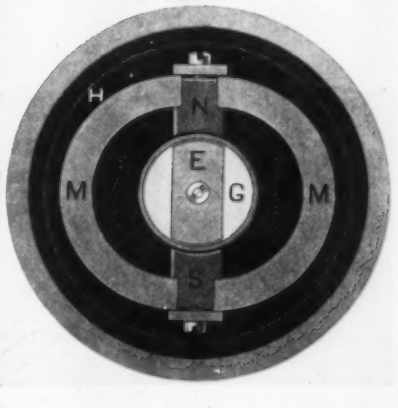
This new design, of itself, makes for maximum "rigidity" of coupling even with ordinary iron magnets. In addition to design, however, the use of cobalt magnets, M M, provides greater flux density. These cobalt magnets are of the permanent type and since the magnetic field is at all times maintained through rotor E, their permanency is unconditionally guaranteed by the makers.

The external magnet assembly M M N S is fastened to shaft J (see Fig. 1) which is mounted on 2 sealed ball bearings, and the end of J projects into the instrument case where the pinion moves the pen arm. There are 3 adjustable balance weights whereby each assembly is individually adjusted at the factory for "perfect rotative balance." The presence or movement of large masses of iron near the instrument will not affect the magnetic coupling, by reason of shield H. The coupling is said by the makers to operate the pen "as positively as a rigid mechanical coupling would."

Manometer. This is of the usual mercurial class with float in one leg and the other leg replaceable for changing the range; but an unusual feature is the submersion of working parts in the mercury, permitting the direct application of the instrument to many corrosive fluids without interposing sealing chambers. These working parts, moreover, are made of stainless steel.

By means of chain B and pulley C, float motion is transmitted to rotor E (and hence to pen-arm) without angularity effect or lost motion. Manometers are furnished either with both legs cylindrical or (as recommended by makers) with high-pressure leg machined to a curved longitudinal section whereby float motion in low-pressure leg is proportional to the square root of the differential pressure. For measuring the differential produced by a properly selected primary metering element, the use of these "parabolic" high-pressure chambers permits the use of charts uniformly graduated in units of quantity-rate of the metered fluid. Machined from steel forgings, the manometers are tested to 5000 lbs./in.² and rated for 2500 lbs./in.² maximum working pressure.

A needle valve L at the bottom of the high-pressure chamber (just above the connecting tube to the low-pressure leg) damps out extreme fluctuations and can be adjusted with a screw-driver while the instrument is in service.



The check valve, to prevent blowing out of mercury, is made of stainless steel. Fig. 2 shows this valve K in its normal position, midway between upper seat P and lower seat R. Being immersed in mercury, K tends to rise but is prevented by its collar which presses upward against weight W hanging from yoke T. Should a negative differential cause mercury to rise higher than its normal maximum, it would float W and allow K to rise and close R. Should an excessive differential cause mercury level to fall below its normal minimum, K would fall of its own weight and close P.

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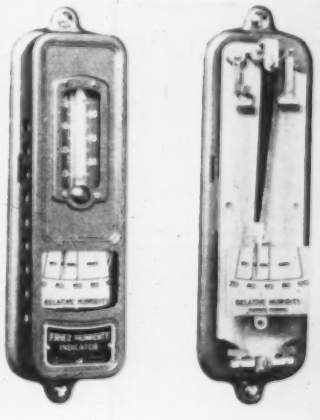
Hair Hygrometer

Julien P. Friez & Sons

POINTER indications of relative humidity on a scale reading from 20% to 100%, as well as room temperature indicators, are provided by this new Relative Humidity Indicator, the hygrometric element of which consists of 54 specially treated human hairs. The instrument is 7½" high, 2" wide and 1¼" deep. The movement is mounted independently, so that case distortion due to uneven wall surface causes no error. The cover comes sealed and the makers issue a service guarantee for the first year and subsequent years, based on unbroken seals.



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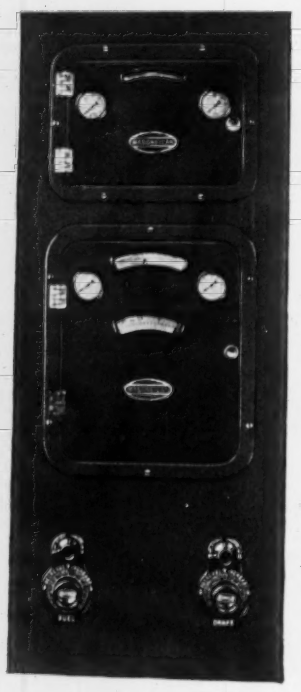
Sartorius Preliminary Balance

Pfaltz & Bauer, Inc.

IN many industrial laboratories for groups of control or check samples, an accuracy of 0.1 g. is sufficient. The preliminary balance gives these results quickly and without the use of weights. Its capacity is 200 g. It is constructed on a sturdy tripod with leveling screw for adjusting the zero point, and enclosed in a solid aluminum case finished with black crystal lacquer. Counterweight and beam turn on a precision ball bearing attached to the column. Hanger for suspending the pan is also provided with ball bearings which are said to be far superior to knife edges. The weight is easily read from a silvered scale attached to a circular segment on the front end of the beam. The scale is illuminated by a mirror attached to the case. It has 400 divisions each corresponding to 0.5 g.; 0.1 g. can be estimated.

Compensated Combustion System

The Neilan Company, Ltd.



THIS newly perfected compensated combustion control system, as may be seen from the illustration, really consists of two parts. The upper instrument is a compensated boiler pressure controller, while the lower and larger is the compensated draft controller. The system is suitable for oil-fired, stoker-fired or pulverized coal installations. It is said to display in service a characteristic mode of control described as "smoothness of control," which is said to be characteristic of all Neilan control instruments. The new system functions so as to render boiler control entirely automatic. It controls the supply of fuel, regulates the speed and position of dampers or blowers or combinations of the two, so as to insure, it is claimed, perfect combustion at all times. The Neilan Combustion Control System is furnished on a suitable panel board with a special manual control feature which permits either of the two instruments to be thrown out at will and the boiler controlled manually. The system utilizes compressed air as an operating medium and for this reason the panel board may be removed from the boiler room to a centralized control room when desired. Worth-while savings in fuel, and the elimination of smoke, are said to be attainable results of its installation.

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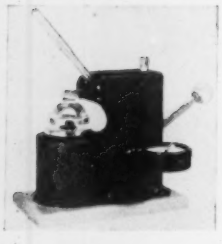
Bursting Strength Paper Tester

Amthor Testing Instrument Co.

TYPE 280 bursting strength paper tester has just been announced. Construction is on the standard hydraulic principle. Operation is controlled by means of the hand lever. The paper is clamped as usual. Then, one downward movement of the hand lever forces a fluid to exert a uniform pressure against a rubber diaphragm which lies flat against the surface of the paper. This pressure, via the rubber diaphragm, is directly distributed evenly over the portion of paper surface under test. The gage is hand-calibrated, Bourdon type, and graduated 0-40, 0-80 or 0-160 lbs./in.^{2} Its pointer remains at the maximum reading (bursting strength) until allowed to fly back to zero on pressing a button.



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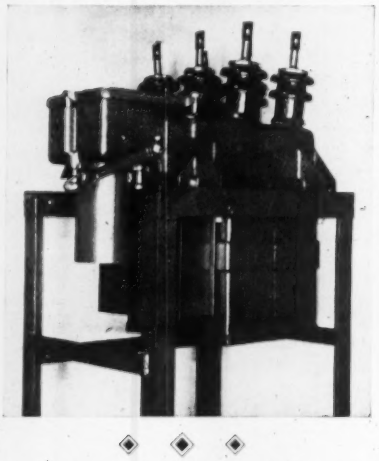
Automatic Reclosing Breaker

Westinghouse Elec. & Mfg. Co.

INTENDED for lightly loaded or rural feeders, a new self-contained reclosing equipment is incorporated in the type FO-22 breaker, 7500 volts, with a 50,000 kv-a. interrupting capacity rating on the 2-OCO duty cycle. The automatic reclosing equipment is mounted within the breaker mechanism housing. It operates over a CO one-second OCO 2.8-seconds OCO lockout duty cycle. The breaker is solenoid operated, from an a.c. source by means of a rectox mounted in a distribution transformer tank. The breaker is tripped by series coils located in the breaker tank. The entire equipment is built for pole mounting but can be mounted on floor-mounted framework.



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A. C. Utility Meter

Shallcross Mfg. Co.

A MULTI-RANGE, multi-purpose meter having facilities for every possible measurement, a.c and d.c., would naturally be somewhat complicated and relatively expensive. To overcome these objections, there has been designed the No. 681 Quick Changed.c.Volt-Ohmmeter and the No. 685 a.c. Utility Meter. The Shallcross a.c. Utility Meter No. 685 will provide essential a.c. voltage measurements and a wide range of impedance measurements using the universally available 110 volt 60 cycle commercial power. In order that this instrument will be of maximum value to radio servicemen and others requiring such test apparatus, the impedance ranges are calibrated in inductance, capacity and resistance. As a result, it is possible to obtain any of the following voltage, capacity, inductance and resistance ranges.

A. C. Volts 10-25-500-1000 (1000 ohms per volt)
Resistance 25-50,000-500,000-5,000,000 Ohms
Capacity .0005 to .1-1-10 Mfd.
Inductance .5 to 100-1000-10,000 Henrys

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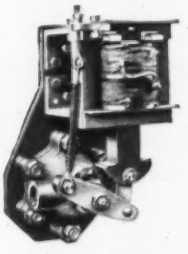
Solenoid-operated Pilot Valves

W. H. Nicholson & Co.

FOR operating single- or double-acting cylinders by remote control, from push-button stations or automatic time cycle instruments, these new units are made in 2-way, 3-way and 4-way types, in sizes from ¼" to 1". The 2-way is used as an "on and off" valve; the 3-way is used to operate single-acting and the 4-way, double-acting, cylinders. The cut shows Model S-O 3-way type which, when the current is on, is open and supplies air to one side of a single-acting cylinder. When current is off, the spring returns it to the exhaust position. Model S-R has a ratchet and rotary disk and the solenoid is energized only momentarily to move the disk from one position to another; this type being preferable where the valve is required to remain in a given position for a long time. Both types are available for operation on 110, 220, 440 or 550 volts, a.c. or d.c.



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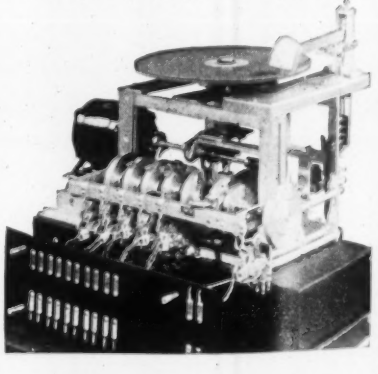
Automatic Synchronizer for Sound and Animation

Operadio Mfg. Co.

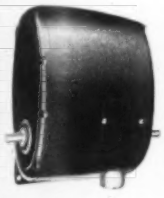
THIS new automatic phonograph and synchronizer, called the Operadio Talk-A-Lite, is used for animating dioramas, exhibition booths, models, show windows, and other displays, and automatically synchronizes voice and sound effects on a phonograph record with changing lights, mechanical movement, or other electrically-controlled animation. As the timing drum revolves, protruding trip fingers pass the mercury switch and flip them into the "on" or "off" positions. Each drum segment can carry 5 pairs of adjustable "on" and "off" trip fingers. No frequency relays are required.



Control System Power Units

Minneapolis-Honeywell Regulator Co.

ESPECIALLY designed for automatic and manual control applications, these power units are inherently electric motor-driven speed reducers or "geared motors." Each incorporates a motor element and reduction spur gear trains. The assembly is a compact, strongly built one to withstand continuous duty service. They may be used in conjunction with the makers' own controlling devices or with those of others, including the products of pyrometer manufacturers, and are available for operation in accordance with the following modes of automatic control: (1) Two-position—(*a*) On and Off, (*b*) High-Low; (2) Three-position; (3) Floating, and (4) Proportioning.



Both non-reversing and reversing single phase, shaded pole induction motor elements having squirrel cage rotors are standard elements. They are available for 110-220 volt, 25-60 cycle a.c. excitation. Furthermore series motors can be supplied for 25 cycle a.c. and 115-230 volt d.c. application.

These motors, except the proportioning types, are functioned from a standard 3-wire control circuit, for example, that common to thermostats, expansion and resistance thermometers, pyrometer indicating or recording controllers, as well as pressure, float, time cycle and remote station switches. Many of these controllers not only are insulated for 110 or 220 volts but also can handle the small current of these motors. Where necessary to interpose a relay between the controller and the motor the Company builds dependable ones for this service.

The maintaining switch, of the *2-position control* motors, performs two functions; first, in limiting the rotation of the shaft to successive 180° amplitudes; secondly, in deviating the circuit from the controlling instrument to its relatively heavy switch track after a very short duration of controller contact, this interval being dependent upon the timing selected. As a result the controller contacts are required to make the circuit and to hold only for this very short period. The maintaining switch provides for a snap action break. Facilities for manual operation can be included on special order, for emergency manipulation without disturbing the electrical control.

With the *proportioning types* a controlling instrument actuating a slide wire mechanism is requisite. These motors contain the balancing potentiometer of the system as well as a means for adjusting electrically the limits of shaft oscillation. Furthermore they include a dual potentiometer which permits paralleling of motors in a cascade arrangement.

In the case of *3-position control* a proportioning motor, in conjunction with its relay, is used, but the governing instrument can be any standard 3-wire primary controller.

Floating control employs the same motor that is furnished for proportioning service but disregards the balancing potentiometer connections.

Together with the gear train and switching mechanism, the motors are assembled in a totally enclosed, dust- and splash-proof housing. The cut high-strength aluminum gears and steel pinions are packed in sufficient grease to last indefinitely. When the gear reductions give the shaft from which a valve mechanism is driven ½ revolution in 30 seconds, it denotes 30 second timing of the valve from full open to tight closed positions, or vice versa. Shaft extensions are slotted for No. 2 Woodruff keys. Electrical connections are made through the ½" conduit entrance in the housing.

Applications: On account of the adaptability of these motors to damper regulation and the ease with which their electrical circuit can be interconnected with motorized fuel-air valves the Company can supply equipment which serves not only to regulate industrial furnace temperature but also to control atmosphere. Among many other uses for this motor is the direct drive of double seated regulating valves of the sliding and rotary shaft stem classifications in a wide range of sizes serviceable in the power, district steam, and all industrial processing fields in conjunction with automatic controllers or remote station switches.

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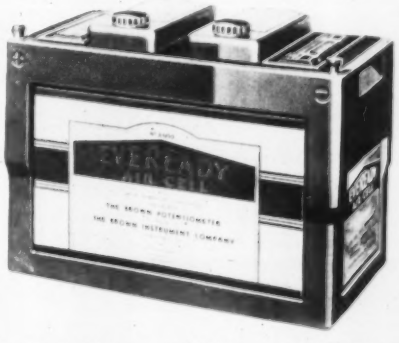
Compensated Air Cell for Potentiometers

By A. H. Koch, M. E.*

A NEW type of battery has been developed which enables the Brown Potentiometer Pyrometer to operate one month or longer without standardizing. The Brown Compensated Air Cell is a wet type non-rechargeable battery, shipped dry and rendered active by adding cool drinking water. It derives its name from the principle of air polarization, the oxygen being obtained from the air rather than from compounds within the battery. It is equipped with a built-in coil which automatically compensates for changes in the temperature surrounding the battery. Therefore, regardless of temperature changes, the Brown Air Cell has a constant current output. This is very important because the accuracy of every potentiometer pyrometer, regardless of make, is dependent on its source of constant current. Dry batteries, which are commonly used as this source of current, do not have this feature and their current output varies due to age and changes in surrounding temperatures. To correct for these variations, it is necessary to frequently balance the current from the dry battery, either manually or automatically, against that of a standard cell. Errors will still exist between these periods of standardizing. On the other hand, the action of the compensator in the Brown Air Cell is continuous, so there is no possibility of errors occurring between periods of standardizing. The large ampere-hour capacity of this cell insures a constant current output over long periods of time and eliminates the necessity of frequent standardizing. The life of the Brown Air Cell is over 2½ years. Its low upkeep eliminates the cumulative cost of replacing dry cells. It can be used with all types of Brown Potentiometers.



*Development engineer, The Brown Instrument Co.

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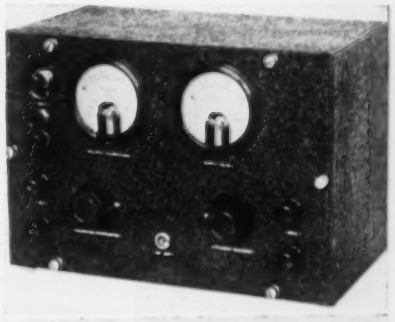
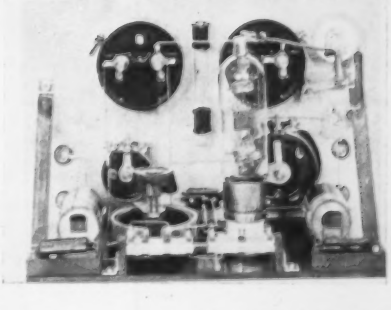
Supersensitive Amplifier

General Electric Co.

WITH this newly-developed device it is possible to measure resistances of a trillion ohms, with only about one volt impressed. Its applications include the measurement of phototube currents in astronomical determinations of starlight, the measurement of radium and X-ray emanations, the study of cosmic rays, etc. In combination with a commercial type of galvanometer, it makes possible the measurement of currents as small as 10^{-15} amp, and when used with a suitable sensitive galvanometer this range may be extended to 10^{-17} amp. The amplifier incorporates a Type FP-54 (10^{-17} amp.) 4-electrode tube, measures approximately 8"x12"x6½", is enclosed in a metal box, and has two controls on its metal panel. So sensitive is the device that a person moving about the room would produce readings greater than those of the input circuit, were it not thoroughly shielded. The circuit is a modification of the Wheatstone bridge, with the plate resistance of the tube serving as one of the legs. A 12-volt storage battery is required to operate the tube. The Type FP-54 tube has a filament, control grid, space-charge grid, and plate. The control grid is insulated with fused quartz inside the tube, and the external control grid circuit must be equally well insulated. The tube is designed to be operated at low voltages and to have very small control-grid current of the order of 10^{-15} amp. The control grid resistance is about 10^{16} ohms.





"Dubl Response" Regulators

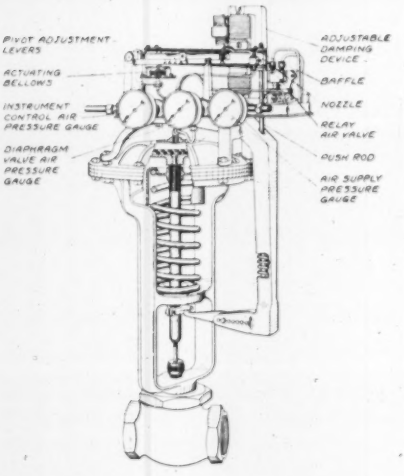
Taylor Instrument Companies

PNEUMATIC operation of control valves in temperature and pressure regulating systems has well-known advantages. The conventional type of air-operated controller, however, has definite limiting characteristics. These are summarized by the statement that close control cannot be obtained unless certain application or process factors remain constant and unless air supply pressure, valve stem friction and other conditions likewise remain constant. Since the majority of industrial process applications involve several variables such as load changes, time lags and unbalanced operating conditions, the usual diaphragm valve seldom assumes the position required at any given moment to satisfy load conditions and maintain the process temperature or pressure at the original setting point. In short, with the usual design of air-operated control system, "the instrument fights the valve." In the newly-perfected Dubl-Response design of air-operated control system, instrument characteristics and valve characteristics are automatically coördinated. The results, it is claimed, are that hunting is eliminated and close control made possible, regardless of load changes or of application lag variations, and regardless also of valve stem friction and other variable control system factors.

The Dubl-Response design departs from the conventional design in 3 respects: (1) The throttling range characteristic of the instrument—i. e., the pen-arm movement corresponding to valve travel from fully opened to fully closed—is made adjustable; (2) the controlled valve is made practically self-operating and inherently self-correcting; (3) the instrument truly commands the valve in that the controlled air from the instrument is not used to operate the valve but only to actuate a small bellows in the new control unit mounted on the valve.

In operation, the actuating bellows of the control unit receives air pressure changes from the regulator, due to pen-arm movement, and positions the baffle with respect to nozzle. Clearance between baffle and nozzle determines position of relay air valve and therefore the air pressure admitted to valve diaphragm. Increased pressure drives the valve stem downward and the push-rod upward. The push-rod is attached, at the lower end, to a pivoted lever in contact with the valve stem just above the stuffing box and, at the upper end, to the nozzle block. Responsive movement of valve stem in therefore exactly proportional to baffle movement since it must continue until baffle-nozzle clearance is correct. This cycle of operation is the initial, or *first*, valve response and the magnitude is proportional to deviation of pen arm from control setting. By the time the process has begun to absorb the initial valve movement a *second* response is started by the Dubl-Response mechanism. This action is independent of pen-arm position and is associated with the damping device and the pivoted levers connected to the baffle. This secondary response, or follow-up valve action, determines the final position of the valve and does so, it is claimed, with micrometer effectiveness. Hence the name Dubl-Response and the term "precision valve action."

The damping device is a closed liquid-filled bellows unit and is adjustable to



match the delay between change in input of controlled medium and response of the regulator or the capacity of the apparatus to react to load changes. Compensation for downward valve stem friction is automatically effected. Should the valve stem momentarily fail to move when diaphragm pressure is increased—relay air valve builds up sufficient pressure to overcome friction. Friction on upward stem movement is compensated for by release of pressure until force of main spring moves the valve into correct position.

The mechanism of the Dubl-Response Control Unit is suitable for outdoor installation. No specially experienced knowledge is required to install or maintain the control equipment. Installation of the recording regulator is the same as for many already in service. The general appearance of the instrument remains the same. After installation, the regulator "sensitivity" and the valve "damping" are adjusted to meet the process time lag and the effect of load changes. These two sliding adjustments make it possible to synchronize the Dubl-Response Regulator "on the job, for the job." Any Taylor Singl-Duty Recording Regulator with serial prefix 33RJ now in service may be equipped with the pneumatic sensitivity-reducing mechanism. The Control Unit may be attached to any Taylor Evenaction Valve—sizes 3M and 5M—now in use. Neither change requires return of equipment to the factory.

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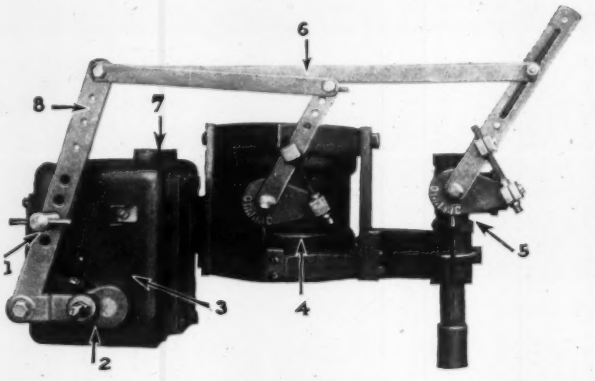
Two-Position Power Unit for Control Systems

Automatic Temperature Control Co., Inc.

TO meet the demand for a sturdy but inexpensive power unit of the 2-position type to operate one or more valves as a unit, a damper or a rheostat, the above company has added to its line of motorized devices a new unit known as "Type 2 Controller," which has sufficient power to operate an air valve up to 4" size in combination with a ½" fuel oil valve, or to operate 2 valves up to 4" size as a unit on low-pressure gas and air. Where furnace atmosphere is important, valves having similar characteristics are provided, each equipped with micrometer screw adjustment for minimum setting and with index and dial plate to permit readily duplicating previous settings. Maximum settings for both fuel and air valves can be obtained by adjusting the connecting links (6) where attached to the valve levers, and where attached to the main operating lever (8). With the valves adjusted for desired combustion, the fuel-air ratio is maintained throughout the stroke. Both valves are moved simultaneously and in unison—a desirable feature not possible where springs or lost-motion linkages are employed. A feature of the new Type 2 Controller is that the fulcrum stud (1) can quickly be removed, thus permitting the attendant to manually move the main operating lever (8) with attached valves to any desired position.



1. 4-position fulcrum
2. Crank shaft and pin
3. Unit housing
4. Air valve
5. Fuel valve
6. Connecting links
7. Housing tapped for conduit
8. Main operating lever

This feature is not only a convenience when starting up a furnace, but it also eliminates the expense of by-pass piping and valves for the air line. Where full pipe line capacity is required, and tight shut-off is essential, Type 2 Controller can be supplied to operate valves of globe body type in sizes up to 3", for pressures up to 250 lbs./in.². Where the medium is at lower pressures, Type 2 Controller has sufficient power to handle larger valves of globe body type. These valves can be provided with an adjustment feature permitting any desired minimum setting up to 50% of valve capacity.

INSTRUMENTS ABSTRACTS

Abstracts on instruments and devices for measurement, inspection and control.

Liquid Level (2.11)

The Arbatsky Water Level Meter for Accurate Tests on Boilers. (Ein Wassermessglas nach Professor Arbatsky fuer genaue Versuche an Dampfkesseln.) J. W. ARBATSKY. *Die Warme*, Vol. 54, Nov. 14, 1931, page 854.

Experiments in the Technical College of Moscow proved that the water level in boilers does not only depend on the quantity of water present but also on the ascending steam bubbles. Feeding a great quantity of cold water, the water level may even fall. The water level meter designed according to A. Arbatsky takes into account the liberated steam bubbles. EF (2.11)

Improved Heater Water-Level Regulator. W. W. CARTWRIGHT. *Power*, Vol. 75, No. 10, March 8, 1932, page 373.

A liquid-level regulator operating on the displacement principle, using the liquid being handled to displace a predetermined amount of the same liquid, is illustrated and described. AHE (2.11)

Alarm System for Float Switch. T. E. MILLER. *Power*, Vol. 75, March 15, 1932, page 410.

Descriptive. AHE (2.11)

Mercury Switches Used on High and Low Water Alarm. C. A. MILLER. *Power*, Vol. 75, June 7, 1932, page 857.

Three Hg switches, 2 - 25 watt lamps, 2 relays, a horn and a float system were used (circuits diagrammed) to serve as a warning of failure of Selsyns in an automatic pumping plant. They could be used to indicate 3 water levels until repair of Selsyns. AHE (2.11)

Level Gage for Molten Glass. F. W. MOWREY. *Chemical & Metallurgical Engineering*, Dec. 1930, page 767.

Describes iron float devices inserted when reading is to be taken. MS (2.11)

Instrument-Type Liquid-Level Controller. *Power*, Vol. 75, Feb. 23, 1932, page 308.

Descriptive. AHE (2.11)

Boiler-Water Level Recorder. *Power*, Vol. 75, Feb. 16, 1932, pages 254-255.

Constant water head is maintained in connection to steam space of drum by means of a steam-condensing radiator and a reservoir. The variable head, or water space, connection is applied over a Hg-sealed bell and the constant head connection is applied to the inside of the bell. AHE (2.11)

Remote Measurement of Water Levels in Open Tanks. (Wasserstandfernmessung in offenen Gefässen). GEO. KEINATH. *Archiv für Technisches Messen*, Vol. 1, March 30, 1932, section V 389-1, pages T17-18.

Discusses electrical telemetering of the height of floats in tanks or large artificial lakes in power work where a small change in height means a great amount of energy. Several devices are described in detail where the movement of the float sends current impulses over the line by a contact arrangement, or changes an ohmic resistance or an inductance for the remote transmission. The inherent errors of a float are discussed. Ha (2.11)

Remote Water-Level Installations of the Municipal Water Plant of Messina. (Wasserstandsfernanlage der Staedtischen Wasserwerke Messina.) W. AHRENDS. *Gas & Wasserfach*, Vol. 74, May 23, 1931, pages 476-479.

Equipment of mostly German design. EF (2.11)

Remote Level Meter. (Behaelterstand-Fernmessung.) J. MOELLER. *Gas & Wasserfach*, Vol. 74, July 11, 1931, pages 658-661.

The principles underlying the customary measuring instruments for liquid level are schematically pointed out. The paper deals particularly with electrical methods (body floating on the surface, manometer at the bottom, resistance wire which is more or less short-circuited by the liquid); also with water level measurement in boilers, and shows the application of the ring balance principle in connection with the use of compressed air bubbling through the liquid for water level measurements in inaccessible containers. The author considers also some principles embodied in measurements on gasometers. EF (2.11)

Physical Testing and Inspection (3.1)

Testing Machines. H. O. HEM. *Scale Journal*, Vol. 18, April 1932, pages 6-8.

A few universal testing machines for physical properties are described quite generally. Ha (3.1)

Testing of Refractory Materials. (Prüfung feuerfester Stoffe.) W. STEGER. *Archiv für Technisches Messen*, Vol. 1, March 30, 1932, section V995-1, pages T20-21.

The nature of refractory materials is defined and methods for determining their chemical composition, the degree of refractoriness with Seger cones, specific gravity, volumetric weight, porosity, shrinking, and growing are discussed and described. Ten references are cited. Ha (3.1)

Determination of the Swelling Criteria of Cellulose. (Ueber die Bestimmung der Quellungskriterien von Zellstoffen.) A. NOLL. *Der Papier-Fabrikant*, Vol. 29, Feb. 22, 1931, pages 114-116.

Methods and apparatus for determining the suction head, linear expansion, absorption of the swelling medium, and the sheet thickness of cellulose are described. EF (3.1)

Determination of the Swelling Criteria of Cellulose. (Ueber die Bestimmung der Quellungskriterien von Zellstoffen.) L. RYS. *Der Papier-Fabrikant*, Vol. 29, May 24, 1931, page 325.

Comment on a previous paper of Noll. (See abstract above.) Being used during a long period of time, the author's apparatus is designed for plotting swelling curves. EF (3.1)

Progress in the Field of Optical Stress Investigation of Structures. (Fortschritte auf dem Gebiet der spannungsoptischen Untersuchung von Konstruktionen.) LUDWIG FÖPPL. *Zeitschrift Verein deutscher Ingenieure*, Vol. 76, May 21, 1932, pages 505-508.

Explains principles of the optical investigation of tensile stresses in laboratory at Munich University and the different methods for different materials: flint glass, celluloid, bakelite and phenolite, the latter 2 however often having interior stressed while glass does not. The application to metals of results found in testing such materials is permissible as the values of the elastic constants and the Poisson constant are without influence on the state of stress. Exceptions are discussed. 13 references. Ha (3.1)

The Impact Resistance of Building-Material with Particular Reference to Mortar, Concrete and Gravel. (Die Stossfestigkeit von Baustoffen insbesonders von Moertel, Beton und Schotter.) A. GUTTMANN. *Tonindustrie Zeitung*, Vol. 55, July 23, 1931, pages 858-860.

Discusses the impact machine of Foeppl using a 50 kg drop hammer. EF (3.1)

Material Testing on Asphalt and Tar for Road Construction. (Die Materialpruefung im Asphalt-und Teerstrassenbau.) W. SZELINSKI. *Petroleum*, Vol. 24, Aug. 26, 1931, pages 3-6.

Reviews methods. EF (3.1)

The Influence of the Pulling Speed During the Tensile Test on Textiles. (Der Einfluss der Zerreisgeschwindigkeit beim Zugversuch mit Textilien.) H. BORRINGER. *Milliand Textilberichte*, Vol. 12, July 1931, pages 441-444.

Reports on exhaustive experimental work at Materialpruefungamt Berlin-Dahlem yielding the breaking time to be the only reliable and significant strength criterion of the tensile tests on textiles. A pulling time of 30 sec. as a standard is urged. EF (3.1)

Tests on Concrete and Reinforced Concrete by Means of the Mikrokomparator with Reference to Pure Bending Stress and to Bending under Axial Stress. (Versuche an Beton und Eisenbeton mit dem Mikrokomparator bei reiner Biegung und bei Beigung mit Axialdruck.) K. LISEMANN & A. FRICKE. *Beton & Eisen*, Vol. 30, Aug. 1931, pages 279-283.

The microcomparator was employed for verifying the "straight line law" with reference to concrete and reinforced concrete. The elasticity figure *Eb* is measured on the same girder with and without an iron reinforcement which yielded satisfactory agreement with present conceptions. EF (3.1)

The Mechanical Testing of Roofing Tiles. (Mechanische Dachziegelpruefung.) H. DENDL. *Tonindustrie Zeitung*, Vol. 55, June 8, 1931, pages 675-676.

Special clamping device for curved tiles is incorporated in a customary decimal balance; breaking load can be directly determined. EF (3.1)

Production Testing and Inspection (3.2)

Testing of Piston Rings. (Ueber Kolbenringpruefung.) E. MAHLE. *Deutsche Motor Zeitschrift*, Vol. 8, Feb. 1931, page 58.

Author calls attention to the "Radiant Tester." EF (3.2)

Twist Determination on Twisted Threads and Yarns. (Drehungsbestimmung von Zwirn und Garnen.) E. SCHMIDT. *Melliand Textilberichte*, Vol. 12, July 1931, pages 445-447.

Refers to the new Kuhn-Zweigle instrument. 3 figs. EF (3.2)

The Measuring Accuracy of Thread Gages. (Die Messgenauigkeit von Gewinderachenlehren.) HANS SCHMIDT. *Die Mesztechnik*, Vol. 8, April 1932, pages 81-84.

In order to increase the accuracy of a measurement the pressure of the gage when measuring a thread should be as small as possible; the measurement should be made under the weight of the gage itself. The variation of the pressure of gages with rolling contact pieces is less than with cone-shaped contact pieces; also the wear is less for the former type. Ha (3.2)

Improved Continuity Test for Enamel Insulation on Wires. C. L. ERICK. *Bell Laboratories Record*, Vol. 10, April 1932, pages 287-289.

The wire is drawn through two rollers under a definite pressure and both rolls and wire form part of an electrical circuit which detects the defects of the enamel insulations by current impulses which influence a discharge tube which will continue to work until a register has operated; then the circuit is restored again automatically for another impulse. Ha (3.2)

Electrical Properties, Tests, Measurements, and Measuring Instruments (4.1)

The Newest Development in Current Transformers. (Die neueste Entwicklung im Stromwandlerbau.) J. GOLDSTEIN. *Elektrotechnische Zeitschrift*, Vol. 53, April 21, 1932, pages 377-380.

The newest designs for instrument transformers for high-est voltages up to 200 KV in Germany and abroad are reviewed. The theories are discussed and features recognized as essential for reliable operation, particularly in open-air installations, are: highest possible safety against short-circuit, thermally as well as dynamically; possibility of obtaining a high secondary output without appreciable errors in the ratio of transformation and phase-angle; high insulating resistance of the primary winding against ground (iron) and secondary winding; and safety of the primary winding against surge voltages. The various designs are examined with respect to these requirements and their construction details illustrated. Ha (4.1)

Re-Ranging Meters. JOHN C. BANK. *Radio Craft*, Vol. 3, June 1932, pages 728-753.

Describes a method whereby the range of an a.c. meter is enlarged by the use of a small bell-ringing transformer; the instrument is connected to either the high or low voltage winding according to whether one wants to extend the range upwards or downwards. The method of calibrating the instrument with the transformer is described. Ha (4.1)

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A Sonic Nephelometer—By J. S. Wilson, B.A., B.Sc., A.Inst.P.

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A Measuring Bridge for the Location of Core Breaks in Cables. (Ueber eine Messbruecke zur Bestimmung des Fehlerortes bei Aderbruechen in Kabeln.) H. CARSTEN & G. VON SUSANI. *Telegraphen-& Fernsprechtechnik*, Vol. 20, No. 2, Feb. 1931, pages 35-38.

An a.c. measuring bridge for the location of defects in long distance cable lines. The detection of the bridge balance is achieved with a d.c. galvanometer by the principle of synchronous rectification. The sources of error of the measurement and their reduction are critically discussed and the results of actual measurements are presented. EF (4.1)

A Simplified Duanten Electrometer and Its Application to Measurement of Alternating Voltages. (Ein vereinfachtes Duantenelektrometer und seine Benutzung zu Wechselspannungsmessungen.) K. ENGEL & W. S. PFORTE. *Physikalische Zeitschrift*, Vol. 32, Jan. 15, 1931, pages 81-84.

A modified type of the Hoffmann Duanten Electrometer is described, the sensitivities are given, and two methods of measuring large resistances are dealt with in connection with the theory of the electrometer. EF (4.1)

The "Mekapion," an Instrument for Mensuring Extremely High Resistances. ("Mekapion," ein Messgeraet zur Bestimmung extrem hoher Widerstaende.) E. KUEHNEL. *Zeitschrift fuer die Fernmeldetechnik, Werk- und Geraetebau*, Vol. 11, Dec. 30, 1930, pages 189-190.

The novel instrument, known as the "Mekapion," was invented by Strauss-Vienna and brought on the market by Bercowitz & Son, Berlin-Schoeneberg. The apparatus, based on the utilization of the three-electrode tube, is suitable for measuring electric resistances between 10^9 and 10^{14} ohms. The application of the "Mekapion" to the testing of insulation material is elaborated on. 3 illustrations are included. EF (4.1)

The Selenium Rectifier. (Der Seleniumgleichrichter.) ERNST PRESSER. *Elektrotechnische Zeitschrift*, Vol. 53, April 7, 1932, pages 339-341.

The fairly weak current rectifying ability of selenium alone can be greatly increased by pressing or spraying on the selenium a thin film of iron or nickel if it is to be cathode, and lead or lead alloys if it is to be anode. The practical development of such rectifiers is described and its characteristic electrical properties and performance explained. Mechanically such a rectifier is built up like a pile: its efficiency is about 60%, but this depends greatly on the current required. It can be connected directly to voltages up to 240 volts. Capacities range up to about 10 watts. Ha (4.1)

Progress in the Construction of Cascade Instrument Transformers. (Fortschritte im Bau von Kaskaden-Messwandlern.) K. GRUENBIG. *Elektrotechnische Zeitschrift*, Vol. 53, April 7, 1932, pages 341-342.

A new construction for a chain of transformers in series for 220 and 110 KV with oil insulation in described, their test voltage is 440 and 220 KV respectively. A review of the development and the present patent situation with regard to cascade instrument transformers is given. Ha (4.1)

Current Transformers with Variable Ranges. (Umschaltbare Stromwandler.) GEO. KEINATH. *Archiv für Technisches Messen*, Vol. 1, March 30, 1932, section Z288-1, page T29.

The change from one range to another is often required (1) in laboratory transformers, (2) in transmission transformers under certain conditions and (3) in operation at temporary overload. While the two former can be switched over without load, this has mostly to be done under voltage in the last type. The different methods of effecting this are described in detail. Ha (4.1)

Transmission Networks and Their Measurement. H. W. ARNOLDSTADT. *Bell Laboratories Record*, Vol. 10, April 1932, pages 296-302.

The arrangements of wave filters, their purposes and performance in communication systems such as carrier telegraphs, carrier telephones and radio systems in general, are briefly described. Ha (4.1)

Design Features of Potentiometers. I. MELVILLE STEIN. *Electrical Engineering*, Vol. 51, April 1932, pages 254-256.

Potentiometers are used now to a very great extent in industrial plants; low resistance apparatus are mostly preferred to high-resistance ones because a higher sensitivity can be obtained with the former, low-resistance coils are more stable, galvanometer damping is easy to obtain; besides at least one-tenth of the total range can be covered with a slide wire. A few modern types are described. Ha (4.1)

Electrical Measuring Devices and Applications (4.2)

Frequency of A.C. Instruments with Dry Rectifiers (Ueber den Frequenzgang von Wechselstrommessinstrumenten mit Trockengleichrichtern). E. HORMANN. *Zeitschrift fuer technische Physik*, Vol. 12, April 1931, pages 222-224.

Course of frequency of rectifier instruments and the correction of the frequency error. Interpretation of the positive frequency error. EF (4.2)

A New Measuring Instrument for Alternating Current. (Ein neues Messinstrument für Wechselstrom.) W. WALLISER-LANG. *Schweizerische Technische Zeitschrift*, Vol. 29, March 17, 1932, pages 160-161.

Disadvantages of new instrument are: limited applicability, insufficient dependability of its readings. GN (4.2)

Utilization of the High-Tension Bridge According to Schering for Investigation of Large Capacities. (Ueber die Verwendung der Hochspannungsbruecke nach Schering zur Untersuchung von grossen Kapazitaeten.) G. ZICKNER & G. PFISTORF. *Zeitschrift fuer technische Physik*, Vol. 12, April 1931, pages 210-213.

Measurements on condensers of 50—7000 μf and low voltages with the Schering Bridge. Suggestions for extending range to 10000 μf. EF (4.2)

The Triometer. (Das Triometer.) ZICKNER. *Zeitschrift fuer Instrumentenkunde*, Vol. 5, Oct. 1931, page 550.

Refers to a precision moving coil instrument built by the R. Abrahamsohn G.M.B.H., for current voltage and resistance measurements with individual, standardized, exchangeable shunt and series resistances and automatic protective relays. EF (4.2)

The Wenner Potentiometer. LEO BEHR. *Review of Scientific Instruments*, Vol. 3, March 1932, pages 109-120.

For the measurement of small electromotive forces the usual potentiometer decade arrangements are not sensitive enough and the contact resistances often influence the result seriously. Wenner has devised an arrangement of the lower decades in which a part of the circuit including the potential point is shunted by a comparatively high resistance. By means of a double dial switch both branch points between the shunt and the main circuit may be shifted in steps of equal resistance to introduce a larger or smaller resistance between the shunting point and the potential point while the shunted resistance is kept constant. This shifting causes a change in the potential difference in the circuit of the respective decade proportional to the resistance not shunted times the current in the shunt. The upper range is 1.9111 volts in steps of 10 microvolts and the lower range is one tenth of this. The limit of error for the instrument is 0.005% or 2 microvolt for the high range and 0.01% or 0.2 microvolt for the low range. The effects of contact resistance, of thermal e.m.f.'s and of errors in adjustment are considered in detail, the construction of the apparatus described and the theory explained. Ha (4.2)

Cathode Ray Oscillographic Methods for the Measurement of Changes of Resistances for Short Voltage Impulses: Investigation of Solid Semi-Conductors. (Kathodenoszillographische Methoden zur Messung von Widerstandsänderungen bei kurzen Spannungstoessen: Untersuchung fester Halbleiter.) W. FUCKS. *Archiv fur Elektrotechnik*, Vol. 26, March 22, 1932, pages 183-192.

Resistance rods of Silite and Ozelite, i.e., mixtures of graphite and silicon carbide with a binder, were subjected to short impulses of voltage to find their behavior as discharge resistances in high-voltage systems. The passage of current in such semi-conductors is explained by the extremely high electric field strength to which the individual grains are exposed and which cause cold electron emission. The time of an impulse as used in the tests was 1.5×10^{-6} seconds. The test methods are described and the curves of resistances as functions of the voltage impressed on the resistors are shown. 14 references are cited. Ha (4.2)

A New Cable Measuring Bridge. (Eine neue Kabelmessbruecke.) THEO. WALCHER. *Elektrotechnik und Maschinenbau*, Vol. 50, March 13, 1932, pages 163-166.

The new bridge, provided with protection against creep currents, gives direct indications without complicated calculation, can be used for supervision during the laying of cable systems, also for locating faults. Ha (4.2)

A New Apparatus for Measuring the Time Lag of the Release of Telephone Relays. (Ein neues Messgeraet zur Messung der Anzugs- und Abfallzeiten von Fernsprechrelais.) B. PITSKER. *Zeitschrift fuer Fernmeldetechnik, Werk und Geraetebau*, Vol. 10, Jan. 30, 1929, pages 1-4; Vol. 10, Feb. 28, 1929, pages 29-32.

The "Tempigraph" is introduced which was designed for measuring the time lag required by electrical telephone relays for making and for releasing contact. Reasons for the development of this instrument by the Oberpost Direktion Frankfurt are given. Its construction and wiring layout and the performance of measurements are fully dealt with. EF (4.2)

An Apparatus for Ballistic Ring Measurements at Elevated Temperatures. (Eine Apparatur fuer ballistische Ringmessungen bei hoeheren Temperaturen.) H. KUEHLEWEIN & H. NEUMANN. *Physikalische Zeitschrift*, Vol. 32, Sept. 15, 1931, pages 727-730.

Describes simple equipment designed for accurate ballistic ring measurements on magnetic materials at elevated temperatures up to the Curie point. The practical utilization of the apparatus is demonstrated by a set of tests with charcoal iron. EF (4.2)

Control of Power Factor. (Leistungsfaktorregelung.) H. KUHL. *AEG-Mitteilungen*, May 1932, pages 172-175.

The apparatus is a rapid regulator after the type of voltage regulators; a small motor with a voltage winding depending on the reactive component and two current windings acts on an aluminum disk which operates the exciter voltage. The operation of the apparatus for different conditions is explained. Ha (4.2)

Zero-Current Indicators for Direct and Alternating Current. (Nullstrom-Indikatoren für Gleich-und Wechselstrom.) JOS. KROENERT. *Archiv für Technisches Messen*, Vol. 1, March 30, 1932, section J850-1, page T27.

Zero-current is defined as a current which is to be made as nearly zero as possible and the deviation of which from zero is to be measured with as high an accuracy as possible. For indicating zero d.c., moving coil instruments, differential and ballistic galvanometers are used; for a.c., telephone, condenser telephone, vibration galvanometer, hot-wire instrument and electro-dynamometers are used. The measuring methods are briefly described. Ha (4.2)

The Influence of Acid Additions upon the Internal Reactions in the International Weston Cell and the Method of Checking the Constancy of its E.m.f. (Ueber den Einfluss des Säurezusatzes auf die inneren Vorgänge im Internationalen Weston Element und die Methoden der Nachprüfung der zeitlichen Konstanz seiner EMK.) H. VON STEINWEHR. *Zeitschrift fuer Instrumentenkunde*, Vol. 51, Oct. 1931, pages 522-535.

Reviews historical development of the Weston Cell. Chemical reactions with reference to acid addition. The investigations in the Technische Reichsanstalt led to the same results at which Shaw & Reileigh arrived *(Can. Journal of Res.* Vol. 3, No. 5, page 473, 1930) Neutral standard cells found superior to acid cells as independent standards for many years, though latter are preferable for ordinary precision or shorter periods. EF (4.2)

Measurement of Small Displacements (Messen Kleiner Verschiebungen.) S. REISCH. *Zeitschrift Verein Deutscher Ingenieure*, Vol. 76, Feb. 6, 1932, page 136.

The displacement is transformed into a capacity change of one of 2 condensers connected in series. The changed voltage between the 2 condensers gives a measure for the change in length or displacement. The 2 condensers are combined into one with two stationary and one movable plate between them. Ha (4.2)

This connection reads the Draft at the last pass of the Boiler on bottom tube.

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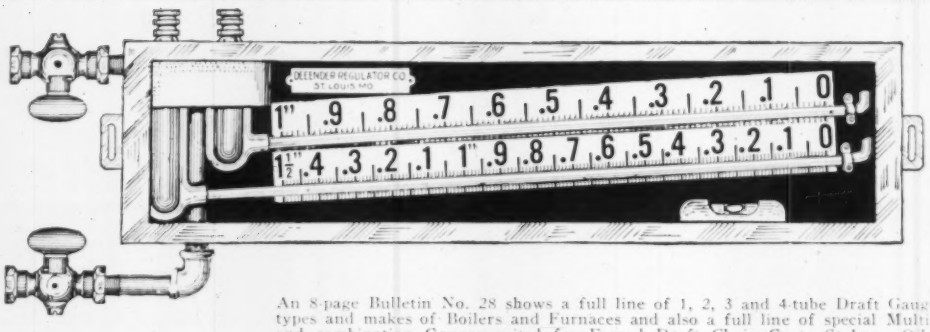
This connection reads the Draft over the fire on the top tube.



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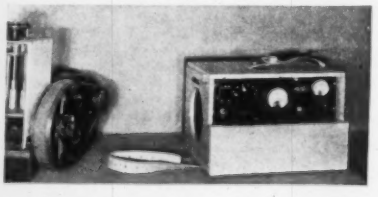
IF THE measurement of noise is one of your problems, the new General Radio Type 559-A Noise Meter will help you. It is inexpensive, accurately calibrated, and portable.



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(2) Response characteristic like that of the human ear
(3) Direct reading in decibels above threshold of hearing
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(5) Inexpensive: Price $190.00 with tubes

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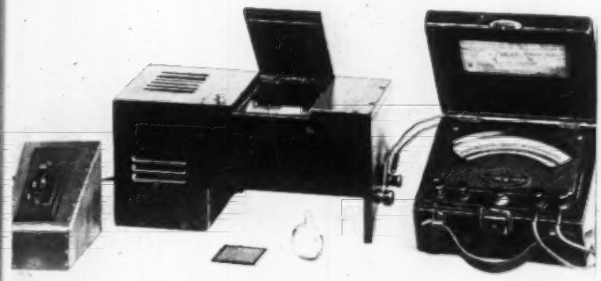

measures the color and transparency of paper and liquids

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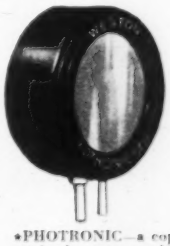
The apparatus consists of a device for transmitting light through the sample to a Weston PHOTRONIC Photo-electric Cell, the output of which is registered directly on an indicating instrument. The instrument reading is a direct indication of uniformity of product. Filters are used when measuring color values.

We will be glad to furnish complete information concerning this instrument . . . . Weston Electrical Instrument Corp., 591 Frelinghuysen Avenue, Newark, New Jersey.



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